THE EMISSARY FORAMINA OF THE CRANIUM IN MAN AND THE ANTHROPOIDS.

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Emissary Foramina of the Cranium.

Introduction.

The emissary foramina of the cranium have been described by many authors, dealing with the parietal or mastoid foramen alone, but Sperino has described all the foramina in a large number of skulls, and has recorded the frequency of occurence of each foramen, excepting only the Foramen of Vesalius, incidentally noting their degree of development.

The only other record of the size of the foramina which I have been able to find is that by Inamaru, who gave an approximate indication of the size of the mastoid foramen, but made no measurement.

At the same time, the only reference which I have been able to find, dealing with the Anthropological aspect of the subject, is from Le Double, and even this is very limited.

Paterson and Lovegrove alluded to the occurence of the Parietal foramen, and Cheatle the Mastoid foramen in animals, while Le Double mentions both and discusses in detail the Comparative Anatomy of the Postglenoid foramen, and emissary foramen commonly present in certain animals, but rarely met with in Man.

In spite of a careful search of the literature of Comparative Anatomy, I have not been able to find any further reference to the subject, which appears to have entirely escaped the attention of zoologists.

In view of the importance of these anatomical facts in regard to paths of infection to the cranial cavity, and the gaps in our knowledge of the Comparative Anatomy, I thought the subject worthy of further investigation, and instituted a research, the results of which are incorporated in this Thesis.

Methods and Material.

In view of the facts before mentioned, I have systematically examined the collection of human crania in the Anatomical Museum of the University of Edinburgh, numbering 1500 skulls. The skulls were not all complete, some parts being missing in certain cases, but allowance for this has been made in the calculations and tables.

This formed the basis of my work, but I supplemented it by observation of the material which passed through the Dissecting Room, while I was there, and this material, though limited, has enabled me to confirm to some extent the findings of my researches on the dried skulls in the Museum.

In studying the problem of age incidence of the foramina, I injected fresh specimens of human foetuses with blue gelatine, as examination of the dried skull alone of infants, is fallacious in certain respects. Detailed reports are included in the Appendix.

Injection experiments were also carried out on adult cranial bones, to investigate the connection of the emissary foramina with the diploic spaces in the interior.

Research on the Foramen Caecum can only be carried out by examination of the interior of skulls, and this is only possible in such skulls as have been sawn open. Museum specimens amounted to 168. I have been fortunate in obtaining 44 additional dried skulls from the Dissecting Room (D.R. Skulls), from bodies dissected in former years, thus increasing the number of skulls available for this purpose to 212.

The collection of normal crania is arranged in Racial Groups, and in recording my results, I have followed closely the Museum Catalogue, and appended the Museum Number to each skull described, so that, if need be, the skulls can be easily identified by a subsequent investigator. From these figures, I have drawn up tables showing the relative numbers and size of the different foramina, and compared the results obtained in the different Racial Groups.

To complete this anthropological survey, I have examined the crania of the Anthropoid Apes in the Museum collection, supplemented by additional specimens from other museums in Edinburgh, amounting in all to 124, and I have compared them with human crania.

I have also examined the crania of other Mammals in the Anatomical and Zoological Museums of Edinburgh University, in view of the fact that so little has been recorded of the Comparative Anatomy of the emissary foramina.

Certain skulls which presented emissary foramina abnormally large in size, I have described in a separate section. I have also alluded incidentally to any other points of interest which I may have found.

The Emissary Foramina of the skull are certain channels in the bones of the skull, containing veins which place the blood sinuses and meningeal veins in the interior of the skull in communication with the extracranial venous system.

They are the Parietal Foramen, Mastoid Foramen, Condyloid Foramen and Foramen of Vesalius, one on each side of the skull.

A single median vein is commonly quoted as traversing the Foramen Caecum. This latter vein is in my experience quite exceptional, and I have discussed it under a separate heading. A single median vein is also very occasionally present, passing through the occipital bone in the region of the external occipital protuberance.

In addition, emissary veins traverse bony canals which are shared by other structures, e.g., the venous plexus running with the Hypoglossal nerve through the hypoglossal canal, and the venous plexus running with the internal carotid artery through the carotid canal, and through the foramen lacerum.
A vein or plexus of veins very constantly accompanies the mandibular division of the trigeminal nerve through the foramen ovale, (especially if the Foramen of Vesalius is absent).

These emissary veins are situated at the base of the skull, and place the venous sinuses of the base in communication with the pterygoid and pharyngeal plexuses, themselves in close communication, and with the commencement of the internal jugular vein, which drains the pharyngeal plexus.

The ophthalmic veins, passing through the superior orbital fissure, place the veins of the face and orbit in communication with the cavernous sinus, and so become emissary veins. The term, in its restricted sense, is, however, limited to the veins previously mentioned.

Lastly, the internal jugular vein traverses the ~~middle~~ posterior compartment of the jugular foramen, but as it is the main channel of drainage for the cranial cavity it is not referred to as an emissary vein, the emissary veins being looked upon as subsidiary channels of secondary importance which assist in equalising the intracranial pressure. There is reason to believe that in the emissary veins, blood may flow either from the cranium to the exterior, or in the reverse direction according to the pressure inside the cranial cavity. In the internal jugular vein the flow of blood is always from the cranial cavity to the exterior, never in the reverse direction.

In the dissecting room, I found one body in which the terminal portion of the occipital vein up to its junction with the mastoid vein, was much larger than the rest of the vein from that point to its termination in the internal jugular vein. The mastoid vein was large, and evidently drained a considerable amount of the blood from the scalp into the transverse sinus, and then to the internal jugular vein.

The first three foramina mentioned, the Parietal, Mastoid and Condyloid, are those commonly referred to as the Emissary Foramina, and constitute the basis on which this research was conducted.

The Foramen of Vesalius is usually very small, not so constant as the other three and must be considered as supplementary to the venous plexus of the Foramen Ovale. It was, however, investigated, and details of its frequency and size are given as in the case of the other three foramina.

My practice was first to see if the foramen was present on one or both sides, and then to measure the bore by means of graduated instruments. The figures were then recorded in tabular form with the Museum number of the skull and the sex as determined by examination of the sexual characters. These results are included as an Appendix at the end of this work.

To make perfectly certain that the foramen was a true emissary channel, I passed a fine strand of silk-worm gut, and only marked as positive, those cases in which this was possible. Many channels, which on superficial examination appeared to be emissary foramina, proved to be incomplete and merely diploic channels. In this fact there is probably to be found an explanation of the varying results recorded by different observers. I was myself struck by the frequency with which such diploic channels were found in the situation of normal emissary foramina, whether there was an emissary foramen present or not.

To measure the foramina, I used graduated wires which were pliable to a certain extent, so that up to a point they could be adapted to a curved canal. I was able to obtain a series of these from a wire manufacturer, measuring 1, 1.5, 2, 2.5, 3 and 4 mm.. Below 1 mm., I recorded every aperture which admitted a hair (strand of silkworm gut) as .5 mm. More accurate measurement than this I considered impracticable and unnecessary.

In many cases I found difficulty in coming to a decision in regard to the bore of a foramen on account of the tortuosity of the canal in the bone, and because in many cases the aperture of the foramen was quite large externally but the lumen narrowed down considerably. This was especially the case in the Condyloid Foramen, which is a canal with a right angled bend, and in the Mastoid Foramen, which may have a long bony canal, is much curved and has a frequent connection with the posterior temporal diploic vein. The Mastoid Foramen often has an S-shaped canal, which may be so tortuous that it is impossible to pass any probe, and one is left in doubt as to whether there is a complete emissary canal or not. Such considerations as these make the figures in some cases dependent on the judgement of the individual observer, and account for discrepancies in results. Where, however, one observer is making comparisons among a large number of skulls which he has himself examined, the comparison is not affected, except in so far as his personal criterion for each observation may have varied from time to time. I have, therefore, examined all the foramina in a large number of skulls - about 1500 - so as to have sufficient data to enable me reasonably to draw conclusions without having recourse to the data of other observers. I have, however, in addition noted the results of others and compared them with my own.

To make sure that a hair or probe passed through a foramen in a skull which was not sectioned, in the case of the Parietal Foramina it was sufficient to look into the interior of the vault through the Foramen Magnum, with, in many cases, the aid of a small electric torch. In the case of the Mastoid Foramen, I found it convenient to pass a large size laryngeal mirror through the Foramen Magnum, and examine indirectly as in Laryngoscopy, shining the hand torch on to the mirror. In the case of the Condyloid Foramen, a hair or probe frequently showed in the jugular foramen. Otherwise the mirror was used.

In the case of the Anthropoid Apes, only the presence or absence of the foramina on one or both sides was recorded, no measurements being made on account of the small size of the crania.

References to results of other workers.

Sperino (39) alone has studied all the emissary foramina (except the Foramen of Vesalius), in 512 skulls, presumably of the Italian race. He refers very roughly to the size of the foramina but has made no measurements of the bore. It is to be noted that Sperino's figures on the Parietal foramen are included in the statistics quoted by Le Double.

Many workers have studied the Parietal foramina alone, and Le Double (25) has collected their statistics and his own, amounting to 3204 skulls, to which must be added the figures gathered by Paterson and Lovegrove (35), 204 skull-caps, Maciesza (27), 150 skulls, and Greig (15), 670 skulls.

The authors quoted by Le Double are as follows:-

French crania.	Augier described	628.
	Le Double	235.
Italian crania.	Vitali	927.
	Sperino (39)	454.
	Legge	760.
Russian crania.	Gruber (17)	100.
Bavarian crania.	Ranke	100.

(From Sperino's 512 crania, 58 skull-caps were missing, thus making the figure 454 in the table).

Le Double, in an anthropological note, points out that the parietal foramina are more frequently absent in White Races than in primitive races such as Australians.

He also describes the Mastoid and Condyloid foramina, and discusses the Foramen Caecum, but gives no figures as to frequency and size.

He examined the crania of animals in his possession, without being able to find a Parietal foramen, and quotes Ranke who examined the skulls of 50 Orangs and 70 Hylobates in an investigation on the Parietal foramen. Le Double makes a passing reference to the Mastoid foramen in certain animals, and discusses fully the Postglenoid foramen in Man and animals, quoting from other authors. To investigate this latter foramen in Man, he himself examined 200 human skulls.

Paterson and Lovegrove (35) also examined 85 parietal bones of nine months foetuses, and found the Parietal foramen present only in the bear, ox and leopard, in the animal skulls in their possesion.

Greig (15) has also described and discussed in detail Abnormally Large Parietal Foramina and has made a complete summary of the literature of the subject. For a full Bibliography, reference must be made to his article, and to that of Pamperl (34).

Cheatle (4), who examined 1500 dry skulls in the Museum of the Royal College of Surgeons, England, discusses the Mastoid emissary foramen, but gives no figures as to frequency or size. He describes two skulls with abnormally large mastoid foramina. He found the mastoid foramen in the dog, dingo dog and horse, but gives no further details of comparative anatomy.

Inamaru (20), working on 60 skulls, presumably of Japanese, has indicated the size of the Mastoid foramina approximately, but has made no measurements of the bore in millimetres.

Knott (22) has examined a limited number (44) of fresh skulls in the dissecting room, and described the venous sinuses of the dura mater and emissary veins.

Mall (28) discusses the embryology of the Post-glenoid foramen, but an even more recent account of the embryology of the vascular system of the Brain in the Human Embryo is given by Streeter (40), and I have extracted a summary to complete my subject.

Lewald (24) and Jefferson and Stewart (21) have described the emissary veins from the point of view of Radiology, especially in their connection with diploic veins.

Parietal Foramen. Position.

The parietal foramen is situated at the upper border of the parietal bone, nearer the posterior end. I measured the distance of the foramina from the middle line and from the bregma and lambda, and I have found that the position of the foramen varies within fairly defined limits. It lies from 5 to 10 mm. from the sagittal suture, very rarely as much as 15 mm. away from it, and sometimes less than 5 mm. from it. When the foramen is present on one side only, it tends to lie nearer the middle line than usual.

In some cases the foramen is median in the saggittal suture, or in the position of the suture, when this is ankylosed. It is difficult to be sure when a foramen is exactly median, and when it is a millimetre or two to one or other side. It is possibly on this account that the figures of different observers do not agree in the percentage of foramina classes as median.

The foramen was with very rare exceptions at least 8 cms. behind the bregma, and varied from 2.5 to as much as 4.5 cms. from the lambda. The distance from the bregma compared with the distance from the lambda varied from 2:1 to 4:1.

Parietal Foramen. Content.

Le Double (25) states that the parietal foramen contains a branch of the occipital artery and a vein placing the superior saggittal sinus in communication with the occipital vein. Abnormally, the foramen is filled with areolar tissue, more or less ?, yes

Relative Numbers in Racial Groups.

Parietal Foramen.

Name.	A.	B.	C.	D.	E.	F.
Scottish.	15.1	21.1	10.5	51.1	2.2	225
English and Irish.	15.1	23.5	12.8	42.5	6.3	47
British.	15.4	21.3	10.7	49.6	3.0	272
Europe. (others)	14	21	16	46	3.0	135
Europe. (total)	15	21.1	12.5	48.4	3.0	407
India.	28.2	16.3	16.7	33.5	5.3	227
Asia. (others)	26	23	12	35	4	129
Africa.	22.1	21.5	10.4	42.3	3.7	163
Oceania.	20.5	21	16.1	39.3	3	186
Australia.	16.3	21.9	18.5	35.8	7.5	293
New Zealand.	11	21.5	21.5	35	11.0	55
America.	24.2	20.2	20.2	34.4	3	101
General <u>Total</u>.	19.92	20.7	15.18	39.59	4.61	1561
Females.	19.3	21.6	13.3	42.4	3.6	533
Young Skulls. (below 25)	20.9	16.4	14.9	44.8	3	67

A. Both Parietal Forāmina present.

B. Right Parietal Foramen alone present.

C. Left Parietal Foramen alone present.

D. Both Parietal Forāmina absent.

E. Median (sagittal) Foramen alone present.

F. Total Number of skulls available.

dense, or contains only an artery or a venule. In my own experience, I have found a small vein only.

Parietal Foramen. Frequency.

I have arranged the figures for the presence or absence of the parietal foramina in columns in the accompanying table, according to racial groups. From the General Total it is seen that the foramina are present on both sides in 19.9% cases, and completely absent in 39.6%. In 4.6%, only a single median foramen was present. The foramen was present on the right side only in 20.7%, and on the left only in 15.2% of cases, so that it is more commonly present on the right side, in the proportion of 2:1.5. As regards racial groups, with the exception of India, New Zealand and America, where the figures are equal, and Australia where there is only a difference of 3%, it is seen that the greater frequency of the foramen on the right side is shown in the individual groups, being especially marked in European and African crania.

In regard to the absence of the parietal foramina, the figure is higher in White Races, being 42.5% in Anglo-Irish skulls (of which there were only 47), 46% in skulls from the Continent of Europe, and 51% in Scottish skulls (of which there were 225).

When all the European (White) skulls are taken together, the average absence of foramina is 48.4% - well above the average of any other group. Le Double (25) from his own figures and the figures of others, points out that the parietal foramina are more frequently absent in White races than in primitive races, such as Australians, though the figures which he compares are not strictly comparable, as it is clear from the context that not all the writers whom he quotes have taken the same criterion. Still, his evidence is sufficient and adds corroboration to the fact which I have myself deduced independently.

Median Parietal Foramen.

I have found a Median (sagittal) parietal foramen alone present in 72 cases, 4.6%, and combined with other foramina in 20 cases, 1.3%, making a total of 92 cases, 5.9%.

The 20 cases where other foramina were present in addition, were arranged as follows:-

A median foramen accompanied by a pair of foramina, 3 times.
A median foramen do. one right foramen, 10 times.
do. do. one left foramen, 6 times.
do. do. a double left foramen, once.

From examination of the frequency in the various races, I have found that the condition is less common in White races, being present in 3% alone or 3.7% in combination with other foramina on one or other side. In all the other races, a median foramen was slightly more common, and this was most marked in New Zealand skulls, 11% (in 55 skulls), on each occasion a single median foramen, and in Australian skulls, 7.5% alone, and a total of 10.2% with other foramina in combination - a decided difference from the 3.7% in White races.

Comparison of Statistics of Parietal Foramen.

Collected by	A.	B.	C.	D.	E.	F.
Le Double.	1188	548	285	101	1082	3204.
	37.0%	17.1%	8.9%	3.2%	33.8%	
Maciesza.	76	19	14	3	38	150
	50.7%	12.7%	9.3%	2.0%	25.3%	
Greig.	306	86	80	18	180	670
	45.6%	12.9%	12.0%	2.7%	26.8%	
Total.	1570	653	379	122	1300	4024
	39.02	16.23	9.42	3.03	32.30%	4024
Present	311	323	237	72	618	1561
Statistics.	19.92	20.7	15.18	4.61	39.59%	
All included	1881	976	616	194	1918	5585
	33.7%	17.5%	11.0%	3.5%	34.3%	

A. Both Parietal Foramina present.

B. Right Parietal Foramen alone present.

C. Left Parietal Foramen alone present.

D. Median (sagittal) Foramen alone present.

E. Absence of Parietal (or Median) Foramen.

F. Total Number of Skulls available.

Paterson and Lovegrove.
66% Foramen present on one or both sides.
1% Single Median Foramen.
33% Absent on both sides. 204 skulls.

	A.	B.	C.	D.	E.	F.
Sperino's Figures.	30.8%	13.8%	6.8%	9%	39.6%	454

Multiple Parietal Foramina.

These were present as follows:-

Both foramina double,	4.
Both foramina present, the right being double,	12.
Both foramina present, the left being double,	6.
Right foramen alone present and double,	9.
Left foramen alone present and double,	7.

Multiple foramina were present in 38 skulls, 2.5% of cases, and present almost equally among the races. The condition is commoner on the right side, 21:13.

Comparison of statistics of other workers.

In another table, I have compared my own results with those gathered from other workers.

In the first line are given the figures quoted by Le Double (25). Of the 37% skulls with foramina present on both sides, 127(3.9%) are described as having vestiges on the right or left side. This would mean that they should be deducted from the first group as they cannot be called true parietal foramina, and be added to the group of skulls with parietal foramina on one side only or to the group showing absence of both parietal foramina. In the latter case, the result would approximate more closely to the present series, giving 33.1% for skulls with both foramina present, and 37.7% for skulls with absence of both foramina.

Maciesza (27) and Greig (15) both record a high percentage for the presence of the parietal foramina, present on both sides at the same time.

I have spoken to Mr Greig personally and received his assurance that in every case where he recorded a foramen, he was able to pass a hair right through to the interior. His skulls were of different races, but mostly of White races.

Paterson and Lovegrove (35) do not give details of the presence or absence of one or both foramina, but their percentage figures in 204 adult parietal bones, 66% present on one or both sides, 1% single median, and 33% both foramina absent, correspond closely with the general average.

If their figures are included in this manner, a grand Total of 5789 different skulls is obtained.

I have added at the foot of the table, for the purposes of comparison only, Sperino's figures separately, although they are included in Le Double's list, as he alone has made an examination of all the emissary foramina.

I have myself found that the Parietal foramen was undoubtedly present on both sides in 20% of cases. Sperino gives 30.8%, but the figures for a parietal foramen on one side only are correspondingly smaller than mine, namely 40%. In many cases I have found that where an undoubted foramen was present on one side, a trace only was present at a corresponding point on the other side, or an incomplete foramen, which did not admit a hair into the interior of the skull. On casual examination, this would appear to be a pair of parietal foramina, and might be recorded as such.

such. It may be that some of the instances of foramina present on both sides recorded by Spèrino were of this nature, and some such readjustment might well make his figures agree with mine.

Other writers give minute details of Median and Multiple Parietal Foramina, but do not make any comparisons racially, and I did not think it worth while to comment on them. These details can be found by looking up the respective references.

Size of Parietal Foramen.

The Parietal Foramina have been placed in three groups, the first being .5 mm. in bore, the next 1 mm. and the third 1.5 mm. or over. The Foramina on the two sides have been kept separate, and the skulls arranged in racial groups on a percentage basis. As only the Parietal Foramina present, are being dealt with, the numbers available are smaller than in the previous tables, so that a less complete division into racial groups has been made.

Racial Group.	Left side.			Right side.		
	.5 mm.	1 mm.	1.5 mm.	.5 mm.	1 mm.	1.5
White Races.	61.8	30.4	7.8	59.6	33.7	6.6
Asiatics.	60.6	36.6	3.3	51.9	46.7	1.4
Africa.	55.6	40.7	3.7	47.2	47.2	5.6
Oceania.	44.1	44.1	12.8	50.6	41.6	7.8
Australia.	35.6	49.6	14.8	37.0	46.8	16.2
New Zealand.	20	80	0	30	70	0
America.	47.7	47.7	4.6	54.5	40.9	4.6
Total.	<u>51.1</u>	<u>41.3</u>	<u>7.6</u>	<u>49.9</u>	<u>43.2</u>	<u>6.9</u>

Note.

The Parietal Foramina present on each side amount to about 568 for the General Total, Whites 133, Asiatics 134, Africans 63, Oceanic 72, Australians 106, and America 44. New Zealand, having only 30, provides a relatively small basis for comparison.

Parietal Foramen. Conclusions.

(1) Frequency. The Parietal foramen is present on both sides in 20% of skulls, is completely absent in 40%, and is a single median aperture in 4.6%.

A single foramen is commoner on the right side, 20%, as compared with 15% on the left.

(2) They are less common in the White races.

(3) Median Parietal Foramina are relatively more common in Australian and New Zealand skulls, especially when compared with White races.

(4) Size. The foramina are practically equal in size on the two sides.

(5) The foramina in Australian and New Zealand skulls are larger than the general average, especially when compared with White races.

(6) Average size in all races.

In about half the cases, the bore is .5 mm. or under. In only 7% is the bore 1.5 mm. or over, while in the rest it is 1 mm.. Only in one case out of 1500 was the bore above 2 mm., This foramen measured 7 by 5 mm., and is described in a separate section as an abnormally large parietal foramen.

Mastoid Foramen. Position.

The Mastoid Foramen according to Le Double (25) "occurs normally two fingers breadth behind the external meatus, in a horizontal line drawn from the bottom of the fossa situated above the meatus to the posterior edge of the mastoid process* but it has been met with much nearer the mastoid occipital suture, in this suture, in the mastoido-parietal suture, the supra-occipital etc.. When it is situated at a little distance from the lateral sinus it is connected to it by a groove or an intra-osseous canal (intermastoid canal)". Sperino (39) states that ordinarily, the vein passes through the mastoid portion of the temporal bone, but not uncommonly corresponds to the occipito-mastoid suture, but he gives no figures. Knott (22), who examined 44 skulls with the soft parts in position, observed the foramen in the masto-occipital suture in 14%, in the mastoid in 83% and in the occipital bone in 3%. Inamaru (20), working on 60 skulls, found the foramen in 58%cases in the temporal bone, in 37% in the occipito-mastoid suture, and in 5% in the occipital bone. He also states that it lies on an average 3.2 cms. (about two fingers breadth) behind the external acoustic meatus, either on the backward prolongation of a line drawn through the middle of the orbit and the external acoustic meatus, or about 4 mm. above or below this line.

I have not worked out the percentage, but on casual examination of my own records, I find that the foramen is situated in the mastoid-occipital

Foot-Note.

* Le Double here means mastoid portion of the temporal bone, not process.

suture about as commonly as in the temporal bone. It was very rarely that I found the foramen situated in the occipital bone, and entirely cut off from the suture by an intervening portion of bone. In many cases the foramen made a deep notch in either the temporal or occipital bone, but the suture line passed through the foramen or lay along one edge.

Quite often there was an asymmetry, the foramen on one side lying in the temporal bone, while on the other side, it passes through the suture. Where two or more foramina were present, variations were again found. The foramen always passed in a forward direction, and was sometimes much curved, to end in the descending portion of the transverse sinus, joining it on the posterior aspect, just below the downward bend. Sometimes the foramen emerged on the inner aspect of the skull a few millimetres behind the transverse sulcus, in which case, a separate sulcus for the mastoid vein led from the mastoid foramen to the transverse sulcus, as a rule, downwards and forwards. In nearly all cases, the inner aspect of the foramen was situated in the temporal bone, a few millimetres in front of the occipito-mastoid suture, so that the foramen travelled obliquely through the mastoid portion of the bone, even although its external openings were in the suture. In a few cases, the foramen was found in the parieto-mastoid suture. In several cases, a groove was present externally, in the mastoid temporal or the occipital bone, leading from the external orifice of the foramen.

Mastoid Foramen. Content.

The mastoid foramen is said to be traversed by a branch of the occipital or posterior auricular artery, and a vein which drains into the posterior auricular, occipital or deep cervical veins, (Sperino and Le Double). Le Double also says, "When there are several mastoid foramina, the one gives issue to the artery and the other to the vein or to a prematurely divided or to a supernumerary mastoid vein".

In the dissecting-room, I have only been able to find a vein passing through, often of considerable size. In one body which was well injected, I noted a branch of the occipital artery on each side, which entered the mastoid foramen along with a larger companion vein, ran down along the sigmoid part of the transverse sinus and then turned upwards towards the internal occipital protuberance, supplying the dura mater of the entire posterior cranial fossa. The artery was as large as the posterior branch of the middle meningeal artery.

Frequency.

From my own figures, I find that the foramen is present on both sides in 34.4%, completely absent in 31.9%, and present on one side only in nearly equal numbers on the two sides, 16.1% on the right, and 17.6 on the left side. It is therefore present on one or both sides in 68% of skulls, about two thirds.

Inamaru (20) states that the foramen is always

Relative Numbers in Racial Groups.

Mastoid Foramen.

Name.	A.	B.	C.	D.	E.
Scottish.	34.5	17	17.5	31	229
English and Irish.	39.2	17.4	15.2	28.2	46
British.	35.3	17.1	17.1	30.5	275
European. (others)	45.3	10.2	19.5	25	128
Europe. (total)	38.5	14.9	17.8	28.8	403
India.	32.1	19.7	16.5	31.7	224
Asia. (others)	35.3	20.6	20.6	23.5	102
Africa.	36.8	17.4	16.8	29	155
Oceania.	32.4	13.2	18.7	35.7	182
Australia.	25.7	13.6	17.5	43.2	257
New Zealand.	25.5	15.7	17.6	41.2	51
America.	50.5	17.9	14.7	16.9	95
General Total.	34.44	16.07	17.56	31.93	1469
Females.	34.5	17	18	30.5	501
Young Skulls. (below 25)	45.9	11.5	9.8	32.8	61

A. Both Mastoid Foramina present.

B. Right Mastoid Foramen alone present.

C. Left Mastoid Foramen alone present.

D. Both Mastoid Foramina absent.

E. Total of Number of Skulls available.

present either on the left or right side, and in most cases is only present on one side, (in 60 skulls).

Sperino in 512 skulls, only admits to the foramen being absent on both sides in 12 cases, absent on the right side in 7 cases, and on the left side in 15 cases. If, however, there are included 95 skulls where the foramina were said to be very small, the absence of foramina on both sides works out at 20.9%, a figure lower than my own, but a reasonable one. In 32.8% the foramina were normal in size and equal on the two sides. In 143 skulls (27.9%), the foramina were multiple, now on one side and now on the other. My own figures for multiple foramina work out at 10.3% on one or both sides. If these 143 skulls are added to the 22 in which the foramen was admittedly present on one side only, they work out at 32.2%. There are also 14.1% where the foramen on the right side was larger than the left, most of which would have to be added to the group of foramina present on both sides. It is possible, however, that the smaller foramen was not pervious, and that such skulls should be placed in the group with the foramen present on one side only. It is very probable that Inamaru and Sperino have included as emissary foramina, the openings of diploic channels, where there was no opening on the inner aspect of the cranium. Where two foramina appeared to be present on one side, I noticed many times that one opening was for the emissary vein, and the other for the posterior temporal diploic vein.

I have some support in this contention in the fact that my figures for the occurence of multiple foramina work out at 10.3%, while Sperino claimed to find multiple foramiha in 27.9% cases. If Sperino's results are interpreted in the way I have done, his statistics are comparable to my own. I admit freely that the mastoid foramen probably occurs more frequently than I have indicated, but I have already alluded to the difficulty in deciding on the presence of the foramen in those cases where the canal is long and tortuous. I have only enumerated those cases in which I have proved its patency, and I can say without any doubt that the foramen is present at least as frequently as I have stated, and perhaps more so.

In contrasting the various races, it is found that Australia and New Zealand both have a high percentage of skulls with both foramina absent, 43% and 41% respectively, and Oceania 35.7%. In American crania the percentage is low, 16.9%, this being accounted for by the foramina being present on both sides in 50.5%, a high percentage. Otherwise, no great difference can be found among the races.

<u>Multiple Mastoid Foramina</u>.

These were present as follows :-

Present and double on both sides,	19.
Present on both sides, the right double,	59.
Present on both sides, the left double,	38.
Present and double on right side only,	17.
Present and double on left side only,	18.

Multiple Mastoid foramina were found double on one or both sides in 151 cases, 10.3%, the condition being more frequent on the right side, 76:56. It is of equal occurence among the different races, except in American crania, where it is found in 22%, twice as often as in other races, in correspondence with the greater frequency of the mastoid foramina in American crania. The foramina occuring in all races, on one or both sides in 68% cases, the mastoid foramen is found double once in every seven times when it occurs.

In only 4 skulls, the mastoid foramen was found to be triple (0.27%) as follows :-

Eurppean,	triple on left side, single on right side.
Asiatic,	single on left side, triple on right side.
Asiatic,	triple on left side, absent on right side.
African,	double on left side, triple on right side.

Le Double says, of the triple mastoid foramen, "this is very rare. I have only seen three cases, two on one side and one on both sides in 200 subjects".

Sperino claimed, as previously stated, that multiple foramina were present on one or both sides in 27.9% cases, but he gives no further details. I have already discussed his contention.

Size of Mastoid Foramen.

To estimate the size of the Mastoid Foramen, the bore of the canal, when present, was measured on each side. When two or more foramina were present, the sum of the combined foramina has been recorded. The results have been tabulated on a percentage basis in groups according to the size of the foramen, the two sides separately. The total number of foramina amounted to 770 on each side.

The results from skulls of white races were then subtracted, amounting to 220 foramina on each side.

Similarly, the results from Australian skulls were subtracted, amounting to 110 foramina on each side.

The remaining skulls, showing 440 foramina on each side, gave figures closely approximating to the general average.

	.5mm.	1mm.	1.5mm.	2mm.	over 2 mm.	over 1 mm.
<u>On the left side.</u>						
White Races.	21	31	23	13	12	58
Australians.	28	45	17	7	3	27
Other Races.	24.6	38.1	20.5	11.3	5.5	37
General Total.	<u>24.0</u>	<u>37.2</u>	<u>20.7</u>	<u>10.9</u>	<u>7.2</u>	<u>39</u>
<u>On the right side.</u>						
White Races.	14	30	26	14	16	56
Australians.	35	38	19	5	3	27
Other Races.	20.4	34.4	22.2	10.8	12.2	45
General Total.	<u>20.5</u>	<u>33.6</u>	<u>23.0</u>	<u>10.9</u>	<u>12.0</u>	<u>46</u>

The sum of the figures in columns 3,4 and 5 have been added together and placed in a sixth column - over 1mm.

Sperino gives no details of the size of the mastoid foramen beyond those already mentioned, but adds, "This fact of greater development and multiplicity on the right, I found to coincide almost always with the deviation of the Longitudinal Sulcus and its continuation with the right Lateral Sulcus."

Le Double says, "When there is disproportion between the calibre of the mastoid foramen on one side from that on the other it is more frequent that the right is the larger."

Inamaru, described the size of the mastoid foramen as the size of a poppy seed in 57% cases, of a pin-head in 26%, and pin-point in 17%, also stating that the foramen is always present either on the left or right side, and in most cases is only present on one side.

Conclusions.

These facts can be summarised as follows:-

(1) Frequency.

The Mastoid foramen is present on both sides in 34.4% of crania (at least), and is completely absent in 31.9%, (or perhaps less).

(2) It is equally common on the two sides, but a double foramen is slightly more common on the right side.

(3) The bore of the foramen is about 1mm. in diameter.

Details are given in the accompanying table.
In about 10% cases, it is over 2mm. ; rarely it is 4 or 5 mm.. In one case, described separately, the foramen was still larger, at least 6 mm. in bore, and must be considered abnormally large.

(4) The right Mastoid foramen is slightly larger, as seen from the table, but this difference is not borne out by the smaller subdivisions, White races and Australians.

(5) Taken separately, there is found a decided difference in the relative sizes of the foramina in the two groups when compared with the general total. In White races, the Mastoid foramen is larger than the average, while in Australians, it is below the average.

The numbers available for examination seem sufficiently large to enable one reasonably to draw this conclusion.

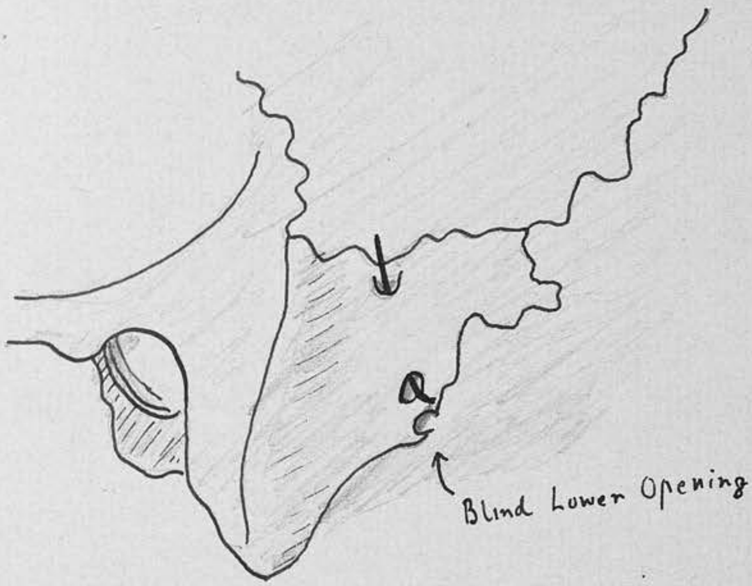
(6) In Australian crania, not only is the Mastoid foramen less common than in other races, but it is also decidedly smaller in size.

The Mastoid foramen is less common in the Anthropoid Apes than in Man, (see later), and when present, in my limited experience, is small in size.

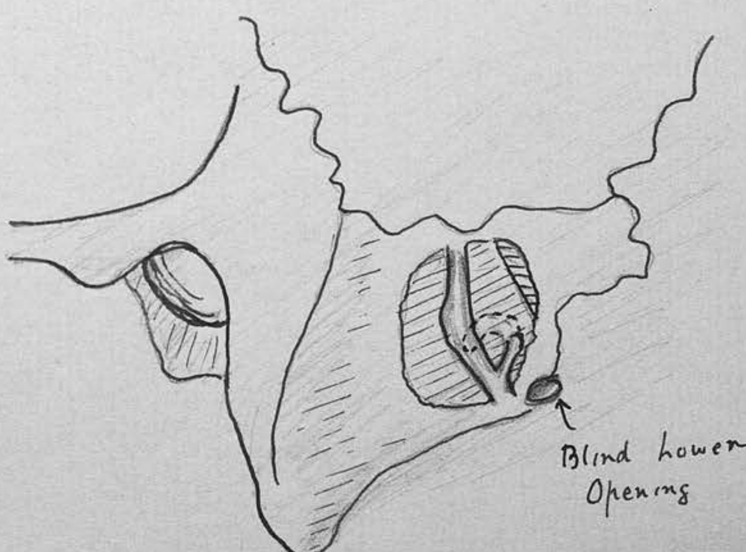
In both respects, therefore, Australian crania display Simian characters.

Sketch of Skull No. 10., 1928. ~~R~~Left Mastoid.

Bone intact, showing Mastoid Tunnel.



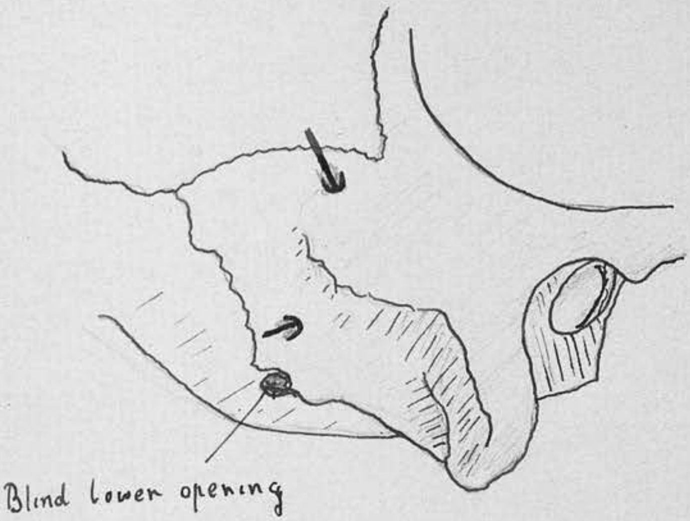
Surface layer of bone removed.



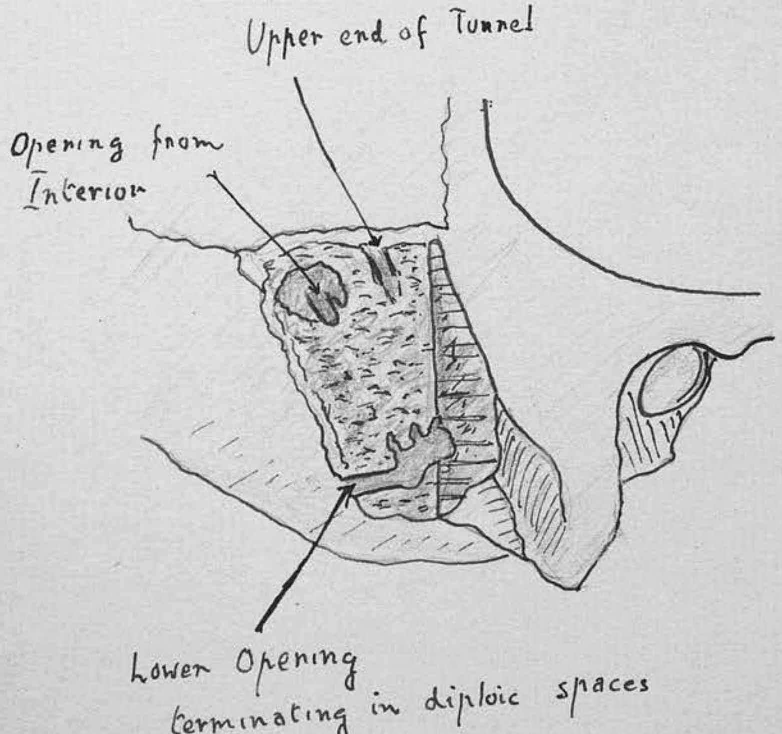
Mastoid Tunnel opened up,
showing an emissary canal, branching off.

Sketch of Skull No. 10[illegible], 1928. Right Mastoid.

Bone intact, showing Mastoid Tunnel.



Surface layer of bone removed.



Mastoid Foramen.

Further Anatomical Considerations.

Cheatle (4) mentions the fact that mastoid air cells may lie up against the mastoid canal in its course through the temporal bone, above, below and on the lateral side, but that they are never found medial to it. In other words, the canal is never surrounded by air cells. This fact is of importance to the Otologist in dealing with suppuration in the mastoid bone.

I have already alluded to the length and tortuosity of the mastoid canal in its course through the temporal bone. In one case I met, it was at least 20 mm. in length, in the form of a letter C, the two extremities almost lying opposite one another. In such cases the wall of the canal is translucent opposite its inner and outer openings.

In quite a number of cases, I have found a groove on the outer aspect of the mastoid temporal bone, bridged over to form a tunnel of greater or less length. A bristle could be passes through from one end to the other, but there was apparently no communication with the mastoid foramen. In other cases the mastoid foramen and tunnel had a common aperture. This tunnel might lodge the posterior auricular artery or its companion vein or both vessels, and in some cases obviously communicated with the emissary and diploic vessels.

To investigate these points further, I removed the bone layer by layer from the mastoid bone in some dissecting room skulls.

In Skull No. 10., 1928, with a mastoid tunnel opened up on each side, the following were the findings. See accompanying sketches.

On the left side there were the two openings of the mastoid tunnel, and below the lower opening, a diploic opening situated in the mastoid-occipital suture. Apparently there was no mastoid emissary foramen, but a small aperture was present on the inner aspect of the bone.

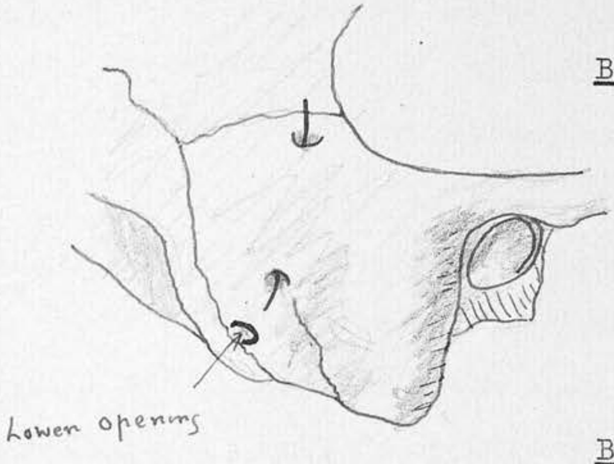
On removing some bone, the tunnel was laid open and was found to widen out, its walls being pitted by tiny diploic openings. Inside the tunnel, an emissary canal branched off upwards and medially into the depth of the bone, and then acutely forwards and downwards, opening into the cranial cavity deep to the mastoid tunnel.

On the right side, externally were seen the two openings of the tunnel and below the lower one, and situated in the suture, was a blind diploic opening. On the inner aspect of the bone was a single opening.

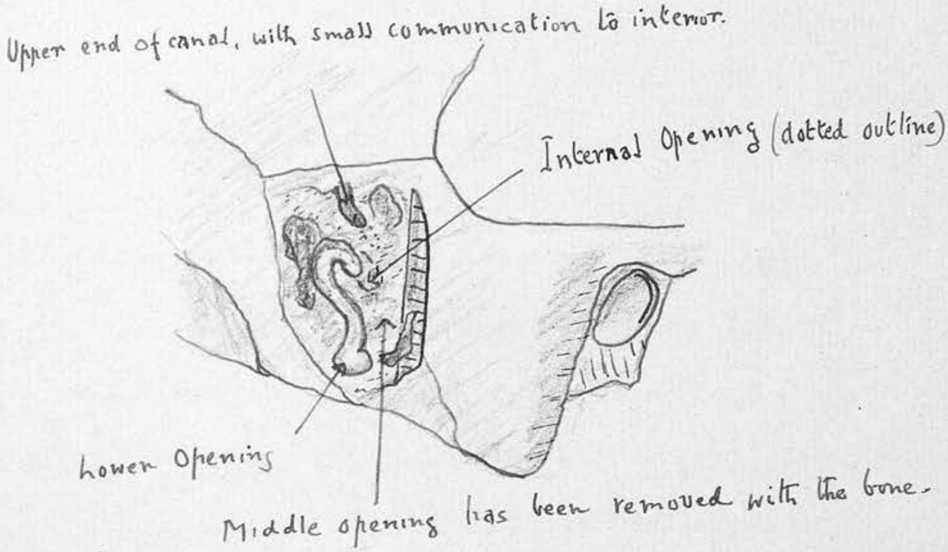
The tunnel was connected with the diploe by small pin-point apertures, but had no communication with the inner opening. This latter ran backwards from the posterior border of the descending part of the transverse sinus and then turned upwards and ended in the diploe, which extended upwards in the mastoid bone as far as the mastoid-parietal suture. The lower external, blind opening was then exposed and found to widen out and branch in diploic spaces.

Sketch of Skull No. 6., 1928. Right Mastoid.

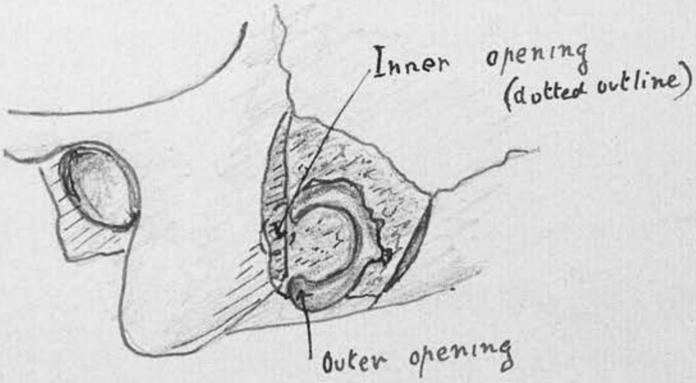
Bone intact.



Bone removed.



Sketch of Skull No. 8., 1928. Left Mastoid.



Surface layer of bone removed to show canal.

The posterior temporal diploic vein ended at the postero-inferior angle of the parietal bone, and formed a small irregular petrosquamosal sinus groove.

Skull No. 6., 1928. Right Mastoid Bone.

No communication could be discovered between external and internal mastoid openings of a diameter of at least 1.5 mm.. A bristle passed up for 20 mm., and seeded to end in a blind channel. A surface tunnel was also present at a higher level.

The bone was opended up with saw and chisel so as to expose the apparently blind canal in the whole of its extent. In doing so, the surface tunnel was removed with bone except for its upper outlet.

There was found an S-shaped canal, of diameter at least 1.5 mm. throughout, with a very sharp bend, in a pocket of which the bristle had impacted. Diploic spaces opened from this as depicted in the sketch, especially posteriorly. The surface tunnel, in bore 1 mm., was connected with the sigmoid part of the transverse sinus groove, 1 mm. above the internal opening on the inner aspect of the mastoid bone.

The S-shaped canal was found to be continuous with the internal opening itself, and was thus a very long tortuous mastoid foramen. Owing to its tortuosity, it was impossible to pass a bristle along it, and prove its patency. It is an example of the condition to which I have referred already, and illustrates the difficulty in coming to a decision sometimes.

Skull No. 8., 1928. Left Mastoid Bone.

In this skull, no communication was found in spite of the existence of well-marked openings both internally and externally. A bristle passes for some distance into an apparently blind channel. The external opening widened out into a cell-shaped cavity from which the bristle passed upwards and backwards.

On opening up bone, a C-shaped canal was found, forming rather more than a semicircle. The outer end was considerably dilated and at the apex of the curve the lumen was wider and opened into diploic spaces posteriorly (see sketch). At the anterior extremity, the canal opened into diploic spaces, anteriorly and superiorly, so that the chances were against a bristle passing completely through the canal to its inner opening, impaction in a diploic space at the convexity of the curve being so easy.

When two openings are present in the mastoid bone, one an emissary foramen and the other a diploic opening, it is usual for the upper and anterior aperture to be connected with the diploe, draining as a rule the posterior temporal diploic vein, and the lower and posterior to be an emissary channel. Very often the diploic openings are multiple and small, but quite frequently there is a single large diploic opening and no opening on the inner aspect of the bone. On the other hand, an internal opening has been found alone, draining the diploe. There is thus an important connection between the mastoid emissary and diploic systems.

Condyloid Foramen.

Position.

The Condyloid Foramen (O.T. Posterior Condyloid Canal), has its external opening immediately behind the occipital condyle, and runs forwards to open into the medial end of the transverse sulcus at its termination, connecting the terminal part of the transverse sinus with the suboccipital plexus of veins and the deep cervical vein deeply in the back of the neck.

So far as I know, it is only traversed by a vein, which may be of considerable size.

Frequency.

From the table, it is seen that the foramen is present on both sides in 46.6% of skulls, a higher percentage than in the case of any other foramen. It is absent on both sides only in 23.1%, a relatively low figure also. It is present slightly more often on the right side, 16.5% on the right, and 13.8% on the left side only.

Sperino (39) gives somewhat similar figures. Both foramina present in 63.5%, both absent in 11.6%, 13.9% on the right side only and 11.0% on the left only. Again, he finds the foramina more often present than I do. Sperino also found that of the foramina present on both sides, that on the right side was in two-thirds of the cases the larger, in correspondence with the greater size of the right transverse sinus.

Multiple (double) foramina are only present in .7% of skulls(10), and 5 occur in African skulls, making a percentage of 3% in that race.

Relative Numbers in Racial Groups.

Condyloid Foramen.

Name.	A.	B.	C.	D.	E.
Scottish.	45.7	16.8	14.9	22.6	208
English and Irish.	45.0	15.0	10.0	30.0	40
British.	45.6	16.5	14.1	23.8	248
European. (others)	52.4	12.1	12.1	23.4	124
Europe. (total)	47.8	15.1	13.4	23.7	372
India.	55.7	16.0	10.9	17.4	219
Asia. (others)	51.0	18.8	16.6	13.6	96
Africa.	45.0	16.6	19.2	19.2	151
Oceania.	43.1	16.6	14.3	25.9	174
Australia.	30.4	17.7	14.8	37.1	256
New Zealand.	38.6	29.5	9.1	22.8	44
America.	73.1	11.8	8.6	6.5	93
General Total.	46.62	16.51	13.81	23.06	1405
Females.	46.6	19.0	17.0	17.4	483
Young Skulls. (below 25)	39.0	26.6	9.4	25.0	64
Figures from Sperino.	63.5	13.9	11.0	11.6	512

A. Both Condyloid Foramina present.

B. Right Condyloid Foramen alone present.

C. Left Condyloid Foramen alone present.

D. Both Condyloid Foramina absent.

E. Total Number of Skulls available.

Size of Condyloid Foramen.

On the left side.

	.5mm.	1mm.	1.5mm.	2mm.	over 2.
White Races.	13.0	17.0	28.7	25.2	16.1
Asiatics.	5.1	25.0	33.3	21.3	15.3
African.	8.8	26.4	25.2	20.9	18.7
Oceanic.	9.9	19.9	30.7	26.6	18.9
Australian.	13.9	23.5	41.7	13.9	7.0
New Zealand.	12	26	45	12	5
America.	10.4	18.2	31.1	24.7	15.6
General Total.	10.1	21.4	32.1	21.4	15.0

On the right side.

White Races.	9.7	24.2	24.2	18.5	23.4
Asiatics.	7.1	18.2	25.3	18.6	36.6
African.	9.1	20.4	32.9	16.0	21.6
Oceanic.	7.6	17.8	28.8	24.6	21.2
Australian.	14.9	29.8	28.1	18.1	9.1
New Zealand.	6	34	25	22	13
America.	7.6	15.2	19.0	46.8	11.4
General Total.	9.1	21.8	26.1	21.6	21.4

The Condyloid Foramina present on each side amount to about 880 for the General Total, Whites 230, Asiatics 220, Africans 90, Oceanic 114, Australians 118, New Zealand 30 and American 78. The New Zealand percentage is therefore only a rough one.

In the various racial groups, there is a decided difference in the figures for Australia, where the foramina are much less frequent than in any other group. The number of skulls in this group is a large one so that the comparison with another large group such as Europeans is a fair one.

When we examine the table showing the relative size of the condyloid foramina, we find that all racial groups agree independently with the general average except Australian and New Zealand skulls, which have relatively smaller condyloid foramina than any other group. Condyloid foramina are very infrequent and of small size in the Anthropoid Apes, so that this appears to be a Simian character. (See later).

Size of the Condyloid Foramen.

The Condyloid foramen varies from 1 to 2 mm., and is thus the largest of the emissary foramina. It is smaller than .5 mm. in only 10% of cases, and in 15% is larger than 2 mm., being arranged on the two sides as follows:- Above 2 mm. in bore.

Left Side.	16	86	15	15	0	0	0
Right Side.	22	100	40	25	3	1	1
Size.	2.5	3	3.5	4	4.5	5.5	6

out of 863 and 898 foramina on the two sides. From the above table and the general table, it is seen that the Condyloid foramina are somewhat larger on the right side. Le Double (25) has also found this, but does not give figures. Sperino confirms this, and has been quoted above. His figures are not so detailed.

Condyloid Foramen.

Conclusions.

(1) The Condyloid foramen is the one most frequently found in human skulls, 46.6% skulls having the foramina on both sides, and only 23% showing complete absence of the foramen.

(2) At the same time, the Condyloid foramen is the largest in size of all the emissary foramina.

(3) It is somewhat larger on the right side, in correspondence with the greater size of the right transverse sinus.

(4) It is less frequently found in Australian skulls and is also smaller than in other races. This is a Simian character, the foramen being found only rarely among the Anthropoid Apes.

Foramen of Vesalius.

The Foramen of Vesalius lies in the base of the skull, piercing the side of the body of the sphenoid, and connecting the cavernous sinus with the pterygoid or pharyngeal plexus of veins. It has a small slit-like opening, emerging externally, antero-medial to the Foramen Ovale, from which it is separated by a small ridge of bone. It contains only a small vein. The outer opening of the foramen is usually more distinct than the inner, and the opening is often funnel-shaped. Very often the foramen is incomplete, having no internal opening. There are often several diploic openings into the sphenoid bone, with or without the presence of a foramen of Vesalius. It is thus closely associated with the diploic system.

It is probable that when the Foramen of Vesalius is absent, the Foramen Ovale is larger than usual, but I cannot bring forward any evidence on this point. This is a matter which might be further investigated.

Frequency.

The foramen is present on both sides only in 14.7% of skulls, and is completely absent in 63.5%. It is present on the right side only in 10.6%, and on the left side only in 11.2%. It is therefore more commonly absent than present, and when present, is twice as often unilateral, being present on the left side very slightly more frequently.

In one skull (XXI.F.22), the foramen was double.

Foramen of Vesalius. Size.

The size of the foramen was found to be very slightly larger on the left side, but no difference could be observed in the racial groups. Most often it was very small, just admitting a hair.

The percentage bore was as follows:-

Bore.	.5mm. and under,	63.7 left side,	65.2 right.
	.5 to 1mm.	30.0	29.2
	above 1mm.	6.3	5.2

In three cases, the bore was 2 mm., and in two 2.5 mm. of which the right side only showed one foramen of 2 mm. bore.

Foramen Ovale.

The Foramen Ovale was noticed to vary in size in different skulls, often on the two sides of the same skull, but no measurements were made, as the oval shape did not permit the use of the round instruments employed elswhere.

In one skull (XVI.C.6.), where the foramen of Vesalius was absent on both sides, a groove, 2 mm. in bore, was found, leading from the site of the Cavernous sinus, antero-lateral to the internal opening of the Carotid Canal, to the Foramen Ovale, which was incompletely partitioned off anteriorly.

On the left side, a smaller groove posteriorly leads from the Foramen Ovale to the groove for the Middle Meningeal Artery. This may be for the

Accesory Meningeal Artery, though it looks too large for that vessel, and we know that the Petrosquamosal sinus frequently ends in the Middle Meningeal vein.

This is the only evidence found on examination of skulls alone, that throws any light on the emissary veins that undoubtedly traverse the Foramen Ovale, probably more frequent and of greater size when the Foramen of Vesalius is absent.

Conclusions.

(1) The Foramen of Vesalius is the least important of the emissary foramina, being the least frequent, absent completely in two-thirds of all skulls. It is also the smallest in size.

(2) When present, it is twice as often unilateral as bilateral.

(3) It is nevertheless important as a channel of infection to the Cavernous sinus, and infection may occur indirectly by the diploic veins in that region when a true emissary foramen is absent.

Emissary Veins of the Hypoglossal Canal.

Owing to the fact that both a nerve and a vein traverse the Hypoglossal Canal, one cannot draw conclusions from differences in size as in the case of the true emissary foramina. I noticed in passing differences in the size of the foramina, even on the two sides of the same skull, differences which must be ascribed to the variations in size of the veins, for the two nerves must remain constant in the same individual. Again, the Hypoglossal Canal was found double, triple and even quadruple on one or both sides.

A double canal does not, however, imply that one portion is for an emissary vein, for the Hypoglossal nerve arises by two roots which pierce the dura mater separately, and may not unite till they are outside the skull. Again, a small artery may accompany the Hypoglossal nerve. I have not attempted to calculate these differences in size and multiplicity, but I quote the remarks of Le Double on this subject. (25).

"Anterior Condyloid Canal (N.T. Hypoglossal Canal). "Increase in Number."

"It has been found double in 15% (on one or both sides) in 795 skulls. Triple in .5%, and quadruple in .3%. To sum up, the Anterior Condyloid Canal is more often double than triple, and triple than quadruple, and in either case, more often unilateral than bilateral."

I saw the emissary vein well shown up in an injected foetal skull. Le Double quotes Batuzeff, who found the Basilar Artery replaced by one passing through the Hypoglossal Canal, from the Internal Carotid.

The Emissary Foramina as a whole.

So far the emissary foramina have been considered separately, but it is useful to consider them as a whole in regard to their incidence in the sexes, in relation to age, and in the various races.

Age Incidence.

For this purpose, I was able to obtain skulls between the ages of 2 years and 25, as estimated by the cranial characters, dentition and sutures. These amounted to 67, and though a small number, the results corresponded quite well with those from the general average of skulls, as will be seen from the various tables. It is, therefore, reasonable to assume, in spite of the small numbers available for examination, that there is no difference in the frequency of emissary foramina in adult and young skulls. The skulls were divided again into smaller age groups, but the numbers were too small and the groups differed from one another without any rime or reason. Had the numbers obtained from the group of skulls between 2 and 25 differed much from the figures of all the skulls, which include skulls of all ages, but mostly adult and aged, one could have drawn no conclusion, but because they tally, one can say that the number is examined is sufficient to justify the assumption that there is no difference.

To prove that there is no appreciable difference in the frequency of the foramina in infants, I examined 9 dried skulls of foetuses or children below 2 years. In these skulls, owing to the shrinking of the sutures which are not held ~~apart~~ taut by the cranial bones, it is difficult to identify the parietal and mastoid foramina, and to compensate for this, several fresh foetuses were injected.

In this connection, it must be mentioned that Paterson and Lovegrove (11) examining the parietal bones of 85 full-time foetuses, "found present in 85% a cleft in the mesial border of each parietal in the position of the parietal foramina, and towards the lateral extremity of this cleft a rounded or oval notch transmitting a blood-vessel.

My results with Foetuses are summarised.

<u>Examination of Dried Specimens</u>. (9).

<u>Parietal</u>.	<u>Mastoid</u>.	<u>Condyloid</u>.
none.	2 pairs.	5 pairs, 1 left side, 1 right side,
<u>0</u>	<u>25%</u>	<u>90%</u>

<u>Examination of Injected Specimens</u>. (7)

<u>Parietal</u>.	<u>Mastoid</u>.	<u>Condyloid</u>.
2 pairs.	5 pairs,	2 pairs,
1 left side,	1 right side,	2 right side,
1 right side,		others incomplete,
<u>60%</u>	<u>85%</u>	<u>60%</u>

In the dried parietal bones, the parietal ~~bones~~ clefts were in 85%, and in the seven fresh specimens in about half the cases. These results correspond to the general average more or less. At any rate, the emissary foramina do not seem to be less frequent in children, if the skulls are examined fresh.

Sex Incidence of the Emissary Foramina.

To investigate the sex incidence, I added up the figures for Female skulls, which amounted to about one third of the total and compared them with the general total. They correspond quite closely, as can be seen from the individual tables, so that one may assume that there is no difference in the frequency of the emissary foramina in male and female. The sex has in each case been estimated from the sexual cranial characters, and in the lists, the letters M and F have been added after each skull.

Incidence in the various races.

To compare the foramina as a whole, a table has been compiled showing the absence of foramina on both sides in the different racial groups. This is an index of the detailed tables of the foramina, which give details of the presence on one or both sides, and has the advantage that the three large foramina, Parietal, Mastoid and Condyloid can be seen from the one table. The figures for the Anthropoids, Simians and other monkeys are given for comparison.

It is found that Parietal foramina are more frequently absent in White skulls (Europe, total), but the figures for Mastoid and Condyloid foramina agree with the general total. In Australian skulls, on the other hand, the Parietal foramina are present a little more frequently than the general average, but the figures for Mastoid and especially Condyloid foramina are decidedly lower than the other groups.

Table showing absence of Foramina

in the various races.

Name.	Parietal.	Mastoid.	Condyloid.	Skulls available.
Scottish.	51.1	31	22.6	208
English and Irish.	42.5	28.2	30	40
British	49.6	30.5	23.8	248
Europe. (others)	46	25	23.4	124
Europe. (total)	48.4	28.8	23.7	372
India.	33.5	31.7	17.4	219
Asia. (others)	35	23.5	13.6	96
Africa.	42.3	29	19.2	151
Oceania.	39.3	35.7	25.9	174
Australia.	35	43.2	37.1	256
New Zealand.	35	41.2	22.8	44
America.	34.4	16.9	6.5	93
General Total.	39.6	31.9	23.0	1405
Females.	42.2	30.5	17.4	483
Young Skulls.	44.8	32.8	25.0	61
Anthropoids. Simians.	83	74	93	42
Other monkeys.	98	51	93	67

A section is devoted later on to Comparative (p.144) Anatomy, but if we compare the figures for the Anthropoid Apes, we find that both the Parietal and Mastoid foramina are much less frequent than in humans, and this is much accentuated when we consider the Condyloid foramen, which is absent in 93%.

If we contrast the Simians with the other monkeys we find that the Mastoid foramen is less common, but the Parietal more common in Simians. This is exactly similar to what we find in Australians, who are ~~known~~ believed to stand low in the Anthropological scale owing to other features. It is reasonable to suppose, as has already been noted in the conclusions appended after the description of the individual foramina, that this distribution of the emissary foramina in the Australians, the Parietal quite common, the Mastoid less common and the Condyloid uncommon, is a Simian character. At any rate, it is in marked contrast to the distribution in the White races, a point already emphasised.

Again, the size is in marked contrast as regards Australians and White races. In Australians, the Parietal foramen is relatively slightly larger, but the Mastoid and Condyloid foramina are decidedly smaller than any other race, particularly the White race.

Emissary Foramina as a whole.

The table also shows that the Condyloid Foramen is that most frequently present, and it will remembered that it is also the largest in size.

The Mastoid Foramen comes next in frequency and in size, then the Parietal, while the Foramen of Vesalius is both the smallest and least frequent.

The Condyloid and after that the Mastoid, will therefore, be the most important emissary foramen in assisting the Jugular Foramen in the drainage of the venous blood of the cranial cavity, and in equalising the intracranial pressure. Yet that is the one vessel which is very infrequent in Australians and the Anthropoids.

Total Absence of Emissary Foramina.

To a certain extent, absence of one set of foramina is compensated for by the presence of another set, but there are a number of skulls which do not have any foramina at all. When I counted up, the actual number was smaller than I had anticipated, thus showing that the compensatory distribution above mentioned is wide spread.

The total number of skulls showing complete absence of foramina amounted to 47 among 1340 whole skulls, in which the absence of foramina could be verified, (many skulls in the tables having a portion missing). This worked out at 3.5%, and 27 of the skulls were males and 20 females - no great difference.

Skulls showing complete absence of Foramina.

The skulls were arranged racially as follows:-

British.	5	in 204 skulls	2.4%
European.	3	126	2.4%
White Races.	8	330	2.4%
India.	5	216	2.3%
Asia.	1	95	1%
Africa.	9	146	6.2%
Oceania.	5	169	3%
Australia.	19	245	7.7%
New Zealand.	0	46	0
America.	0	93	0
Total.	47	1340	3.5%

From this is seen that the proportion in Africans and still more in Australians is high, and as a similar absence of foramina is found in many of the Simiidae, this complete absence of all emissary foramina in Australians and Africans must also be considered a Simian character.

In the Chatham Islands group, 3 skulls were found out of 23, showing complete absence of emissary foramina, giving a percentage of 13, but as only a small number of skulls was examined, the significance must not be overestimated.

The various racial groups of Oceania were compared individually with Australia, but the numbers were so small that very varying figures were obtained. No conclusions could therefore be drawn.

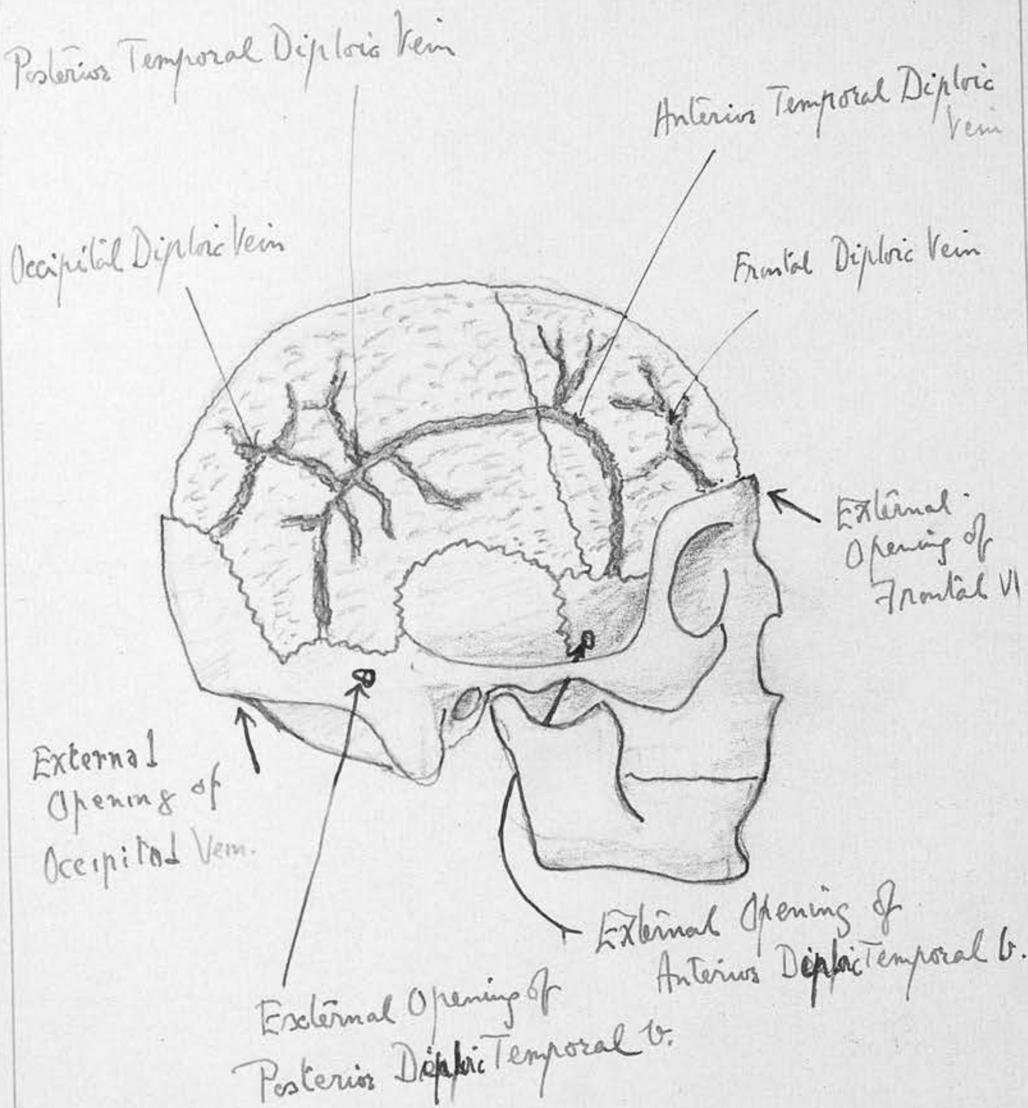
The size of the Jugular foramina and the presence or absence of diploe was not investigated in the skulls which I have examined, owing to the time occupied in the other investigations, and I am unable to produce any evidence as to why certain skulls, previously enumerated, should have no emissary foramina at all. If the Jugular foramen were very large, a additional openings would not be necessary. Still more important, however, is the part played by the diploic veins, which could take the place of the emissary veins in equalising the intracranial venous pressure. I have already alluded to the association of diploic veins and emissary veins, and I shall mention it again when I describe emissary veins which are not normally found.

It will be advantageous to give a brief description of the diploic system.

Diploic Venous System.

The diploic veins are anastomosing spaces in the spongy tissue of the flat bones of the skull, lined by endothelium. There is no true diploe till after the age of six years, and after the sutures have closed the diploe of one cranial bone is in free communication with its neighbour. The diploic veins have both external and internal openings, and it is this factor which produces the important communication between the extra- and intra-cranial venous systems. The diploic system drains by four main veins which are named and emerge at fairly constant points.

Sketch of Diploic Venous System.



Outer table has been removed to expose the diploic tissue and its veins.

The most anterior, the Frontal Diploic vein opens into the supraorbital foramen, or into the superior sagittal sinus, or both.

The Anterior Temporal Diploic Vein opens into the Sphenoparietal sinus or the Anterior Deep Temporal vein or both, piercing the great wing of the sphenoid. Sometimes, several fairly large openings may be seem.

The Posterior Temporal Diploic Vein drains the posterior part of the parietal bone, communicates with the Anterior Diploic Vein and with the Occipital Diploic Vein. Very often, there is a stellate appearance over the posterior parietal bone, and this is shown in the Radiogram of a skull cap figured later on in this paper. It is well shown in the sketch.

This vein opens externally on the mastoid portion of the temporal bone, usually by an opening separate from the mastoid foramen, but frequently into the mastoid foramen itself. It may also open into the transverse sinus at the inner aspect of the posterior inferior angle of the parietal bone.

The Occipital Diploic Vein opens on each side of the median plane below the external occipital protuberance, usually by a long and wide mouthed channel, draining into the occipital vein. It may itself, or one of its connections may open into the Confluens Sinuum (O.T. Torcular), or into the transverse sinus.

Other smaller openings are present on the occipital bone and over the mastoid bone. Quite frequently, I have noticed a diploic vein opening just above the root of the zygomatic process, and in the posterior part of the floor of the mandibular fossa.

The foregoing description applies to the main diploic channels, but variation is seen in the smaller channels. Diagrams made from actual dissections of the skull by Breschet, showing these variations, are published by Jefferson and Stewart (21) in their article on "The vessels of the diploe," These latter authors took radiograms of calvaria, after injecting the diploic veins with lipiodol.

In discussing the connection of diploic veins with emissary foramina, they say, "careful study of these latter (the well known emissary foramina) will frequently show that as they pierce the bone they are joined by diploic veins, a small perforation or two being discoverable in their smooth walls."

At the end of the section on the Mastoid foramen, (pp 33-39), I described some temporal bones, where I removed the outer table of bone so as to open up the emissary foramen. In these cases, I found that the diploic spaces opened into the foramen to a greater or lesser extent. In an occipital bone where there was no condyloid foramen, but merely blind openings externally and internally, I opened up the bone and found that the openings communicated freely with the diploe, and probably very indirectly with one another. In other cases where there was an obviously patent condyloid foramen, a blind channel branched off from it into the diploe.

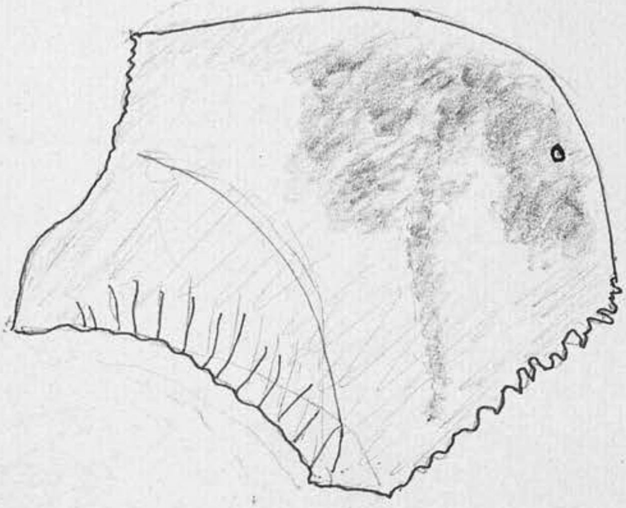
To put the matter beyond a doubt, especially in regard to the parietal foramen, I injected some single bones with a dye, and examined them.

Bones injected with Methylene Blue.

Fig. 1.

Left Parietal Bone

Outer Aspect



Inner Aspect.

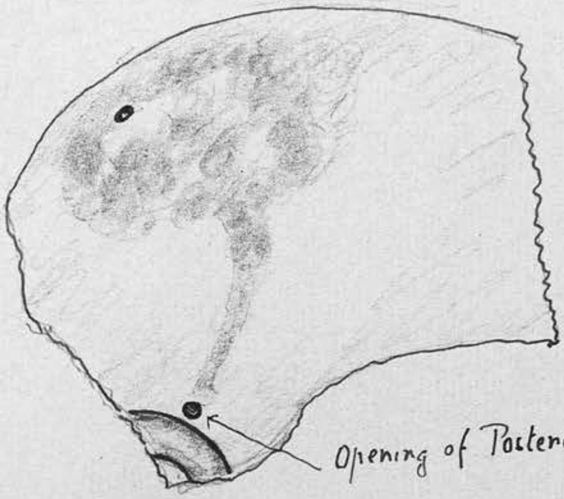
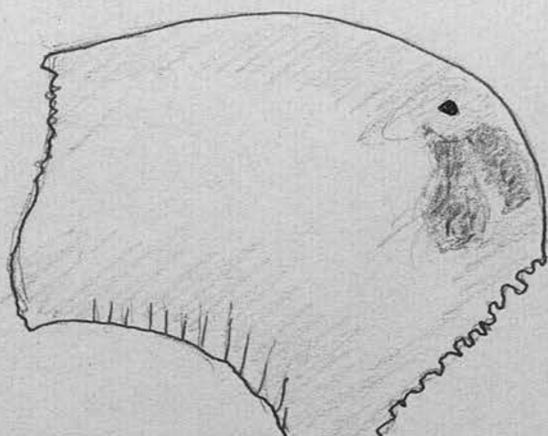


Fig. 2.

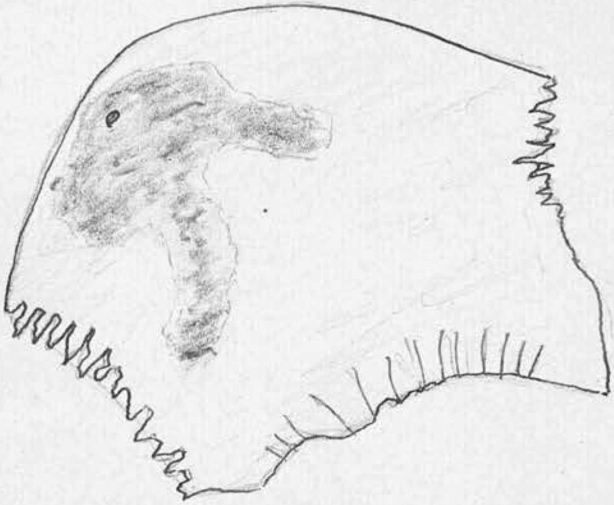


Outer Aspect Left Parietal Bone

Bones injected with Methylene Blue.

Right Parietal Bone.

Fig. 3. Outer Aspect.



Inner Aspect.

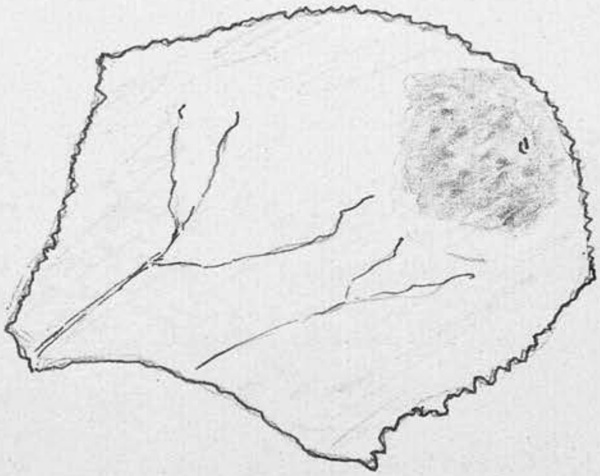
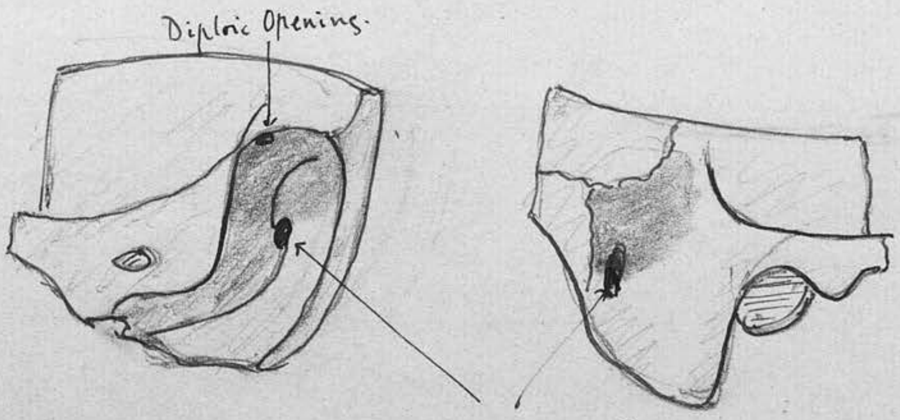


Fig. 4. Right Temporal Bone.



Inner Aspect. Outer Aspect.

Connection of Emissary Foramina with the Diploic Veins.

First of all, I injected some skull bones with Methylene Blue. In each case the emissary foramen was patent and I blocked one aperture with plasticine, and fitted a hypodermic needle into the other aperture, with plasticine round about it to prevent the escape of the injecting fluid.

I injected an occipital bone in this fashion, and at once removed the bone from the internal aspect. The diploic spaces in the region of the occipital condyle were filled with the coloured fluid, but it did not penetrate further into the occipital bone.

I injected three single parietal bones and a thick calvarium, but I waited for an hour after the injection. By that time, and still more so next day, the dye had soaked through the bony tissue in the immediate vicinity, so that it could be seen on the outer and inner tables. In the first parietal bone, there was a large communication with the diploic veins, for the dye flowed out at the time of injction from an opening of the posterior temporal diploic vein on the inner aspect, at the posterior inferior angle, just above the groove for the transverse sinus. Sketches are appended, showing the extent of the injections. The appearance of the dye on the surface of the bone, although it has soaked through porous bone, can be taken as an indication of the passage of the injected fluid through the diploic spaces in the interior. In Fig. 1, the track of the Posterior Temporal Diploic Vein is shown up, and the dye has penetrated for some distance over the bone, to a greater extent externally. In Fig.2, is shown the outer aspect of another left parietal bone, where the dye showed on the external surface to a more limited extent, and not at all on the inner surface. The dye shows a little posterior to the foramen, but not at the foramen itself. In Fig.3, a left parietal bone is shown, with the injection well spread over the external aspect, and in an irregular, blotchy manner, and to a lesser extent over the internal aspect.

I also injected some single temporal bones. In the first, which is shown, the injection at once ran out at a diploic opening at the upper border of the sigmoid groove, just where the transverse sinus bends downward, (see Fig. 4). The dyed area of bone is also shown. I injected some other temporal bones, and noted the spread of the dye, but it may have diffused through from the mastoid emissary ~~tunnel~~ canal itself.

Again, in two parietal bones, which I injected, the dye did not show at all on the surface. I therefore injected these two bones and some other temporal bones with hot Blue Gelatine, and later removed the outer table of bone. I found that in the temporal bones, the coloured gelatine had passed into the diploic spaces to a greater or less extent, sometimes very little. In one parietal bone which was fairly thick, I removed the outer table for an inch round the foramen, and found that the injection had penetrated for about a centimetre all round and still more anteriorly.

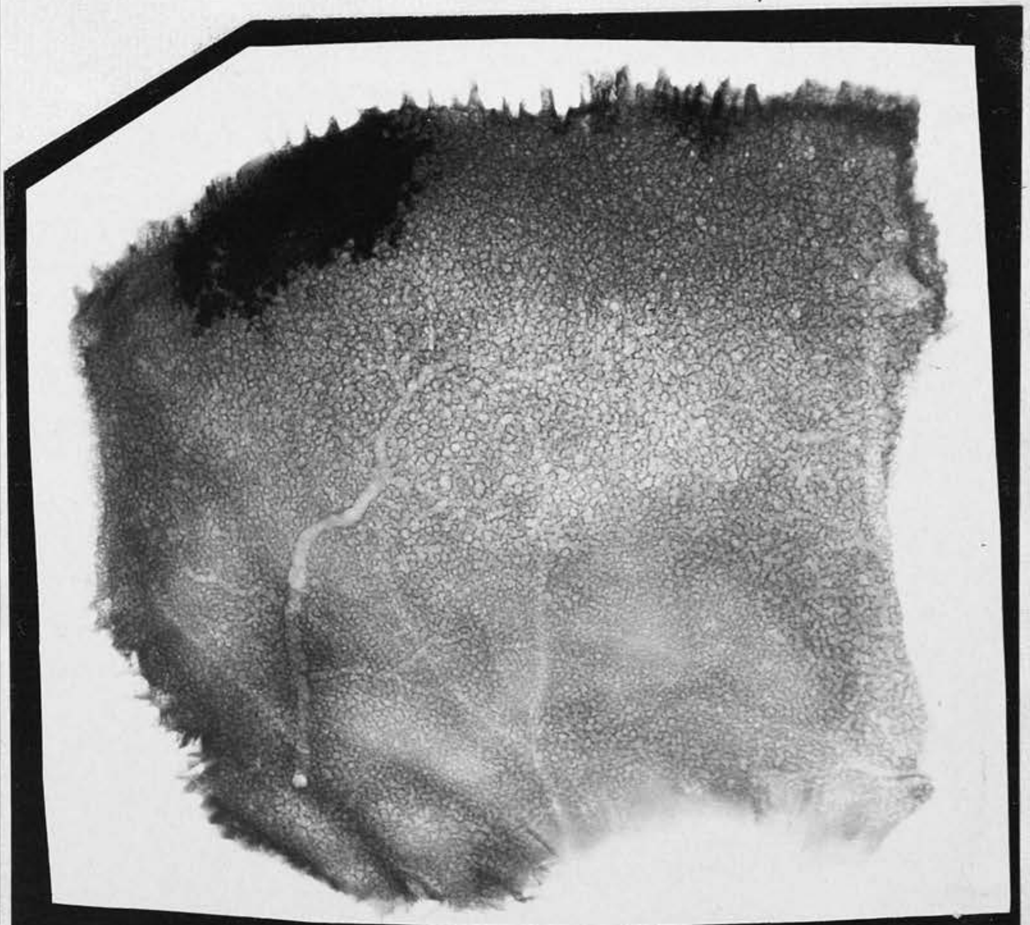
The other bone was a calvarium, which was very thick, and both parietal foramina were injected with hot Blue Gelatine, (injection with Methylene Blue not having shewn on the surface), An area of the outer table was removed for an inch or more round each foramen, and the injection was found to have passed well beyond the foramina right up to the edge of bone removed. In the middle line between the two foramina, the bone was dense, but just posterior to them, there was some cancellous tissue with some injection.

These experiments, though limited, do show that there is a very close connection between the emissary and diploic veins; it may not be in all cases, and apparently varies in the size of the communication.

These isolated bones were picked at random, as pieces that could be experimented on -it was no great matter if they were damaged - and two of them showed a large communication between an emissary foramen and a diploic opening, one a parietal bone, and another a temporal bone.

Radiogram of Parietal Bone shown in Fig. 1.

The diploic tissue has been injected from the parietal emissary foramen, but the injection has not reached the large Posterior Temporal Diploic Vein, which is clearly outlined in the Radiogram.



Radiogram of Parietal Bone shown in Fig. 3.

The diploic spaces were injected from the parietal emissary foramen with Lipiodol, but the injection has not been so intense as with Methylene Blue, shown in the sketch, Fig. 3.

Radiogram of Calvarium

injected with Lipiodol by the parietal foramen. A negative result was recorded after injection with Methylene Blue, and X-ray shows that no Lipiodol has penetrated into the diploic spaces.

Lipiodol Injection of Parietal Bones.

As a third method of examination, I injected the single parietal bones shown in Figs. 1 and 3 with Lipiodol and took Radiograms immediately afterwards. Lipiodol is a thick viscid oily fluid, injected with difficulty, and it gives a dense shadow with X-Rays, so that even a small amount is distinctly shown up in bone. The Radiograms show that the Lipiodol has undoubtedly passed from the parietal foramen into the diploic tissue, but that the injection is more restricted than that produced by Methylene Blue. The Radiogram of the parietal bone shown in Fig. 1, gives a very clear picture of the posterior temporal diploic vein, the aperture of which was noted in the sketch.

I also had another specimen, a thick calvarium, with a parietal foramen on the right side only, which I had previously attempted to inject with Methylene Blue, but without result. This I injected with Lipiodol, but the Radiogram shows that it did not penetrate into the diploic tissue. The dense shadow immediately over the parietal foramen is caused by the plasticine used to block up the aperture. This proves that in some cases, at any rate, the emissary foramen does not communicate with the diploe.

Embryology of the Emissary Veins.

A brief account of the Embryology is given as it helps to explain anomalies of the emissary foramina.

The account is based on the work of Streeter (40) and is a comparatively recent addition to the subject.

The first stage is the formation of the Primordial Vascular System of the head from angioblastic cells, a capillary plexus being formed.

The next stage is the differentiation of the Primordial Vascular System into arteries, veins and capillaries, and can be seen in an embryo 4 mm. long.

This is shown in Fig.1.

A uniform capillary plexus lies closely applied to the brain wall, draining into a Primary Head Vein, which begins at each side of the midbrain, ventrally, and runs back medial to the trigeminal nerves and semi-lunar ganglion, and then lateral and superifical to the 7th to 11th nerves, finally becoming continuous with the Anterior Cardinal Vein. There is thus a Pre-Trigeminal portion and an Otic portion behind it.

In the majority of vertebrates, the primary head vein lies at first medial to the 7th to 11th nerves, but soon disappears. In the human embryo, this stage has not been seen, and does not seem to occur.

Mall named that portion of the primary head vein which passes lateral to the 7th to 11th nerves the Vena Capitis Lateralis.

Plexiform tributaries drain into the Primary Head Vein in three groups, an Anterior group from the forebrain and midbrain, leading into the pre-trigeminal portion of the Primary Head Vein, a Middle groupfrfrom the cerebellar region, emptying into the Otic portion between the 5th and 7th nerves, and a Posterior group from the medulla oblongata, accompanying the rootlets of the Vagus and emptying at the junction of the Otic portion wiht the Anterior Cardinal Vein.

Mall first described these stems in 1904 as Anterior, Middle and Posterior Veins.

The next stage is the cleavage of bloodvessels of the head into three separate systems, the cutaneous the duramatral and the cerebral, and is shown in embryos of from 12 to 20 mm..

This begins in the region of the base of the skull, and spreads up to the vertex. The developing cranium separates the External or cutaneous vascular system from the Dural and Diploic, while the growth of the Dura Mater and Arachnoid separates off the Dural Syatem of Veins from the plexus covering the surface of the brain. Streeter prefers the terms Anterior, Middle and Posterior Dural Plexuses to the terminology applied by Mall, since owing to the cleavage effect of the dura, these vessels belong chiefly to the dura. At the dorsal area of the brain, however, there is a close connection between these vessels and the capillary plexus applied to the brain surface.

The early external vessels appear round the base of the skull, and spread upwards to the vault. There are also vessels draining into the primary head vein, especially lafge and numerous in the neighbourhood of the optic stalk and the trigeminal ganglion, A large plexiform sheet lies median to the maxillary trunk of the trigeminal nerve, draining the strucutres of the maxillary arch. It is continuous with the plexus that envelops and penetrates into the substance of the trigeminal ganglion. It is a modification of this plexus that forms the infraorbital vein, and the venous plexus of the region of the pterygoid fossa. The ophthalmic vein corresponds to the ventral tributaries just in front of this and medial to the first division of the trigeminal nerve. Part of the plexus is retained as the emissary vein of the Foramen Ovale.

The fourth stage is the adjustment of blood channels due to growth and change in the form of the brain and ear.

See Fig. 2.

If an embryo, 18 mm. long, is examined, it is found that the blood from the Middle Dural Plexus now drains caudalwards into the Posterior Plexus through anastomosing channels that exist between these two plexuses, passing dorsal to the Otic capsule, just lateral to the endolymphatic sac. Owing to the pressure of the developing cochlea and middle ear, the Otic portion of the Primary Head Vein, which has an extracerebral course, and joins the Anterior Cardinal vein just distal to the Jugular foramen, now disappears

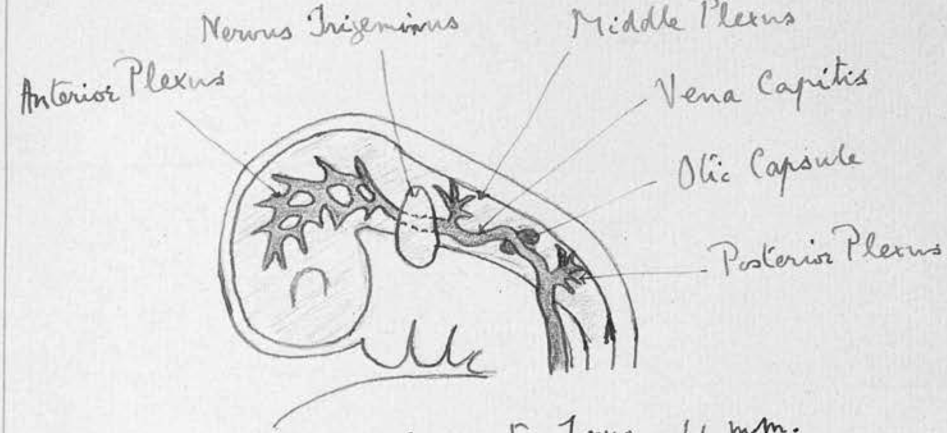


Fig I. Embryo 4 mm.

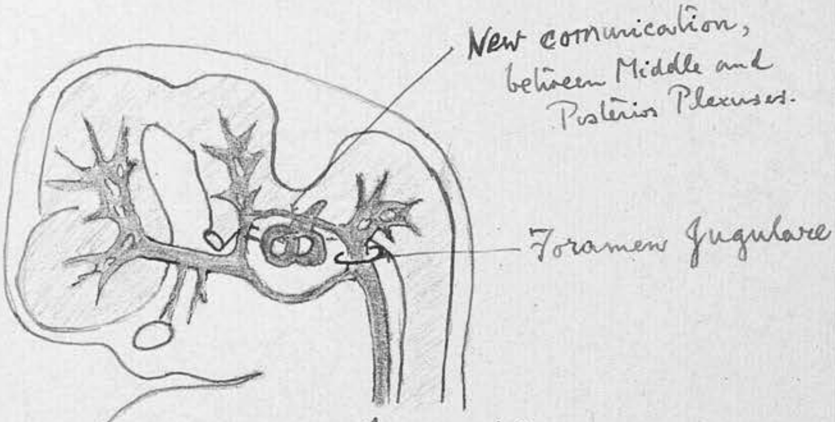


Fig 2. Embryo 18 mm.

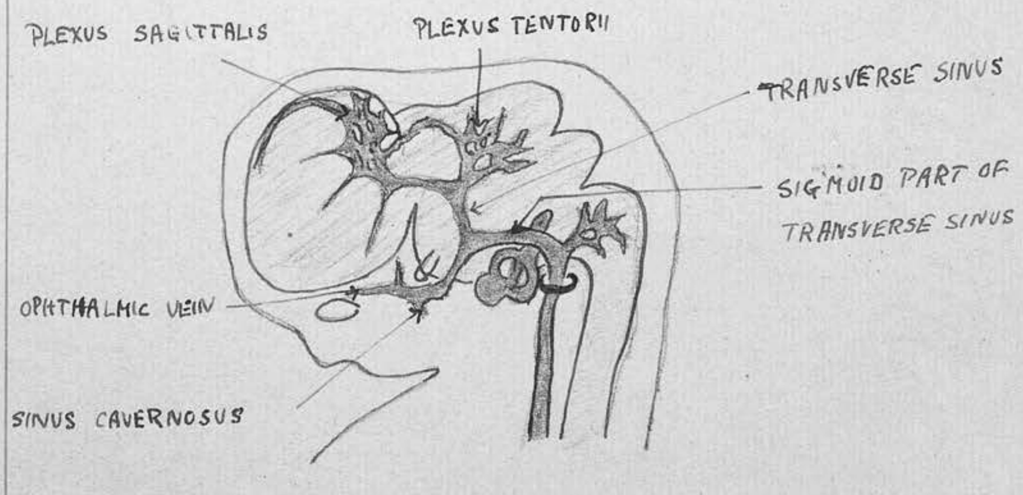


Fig 3. Embryo 21 mm.

- at the stage of a 20 mm. embryo - and the only remnant is a blind channel which extends a short way along the facial nerve. Occasionally, there is found in the adult stage a persistent foramen, "foramen jugulare spurium of Luschka", (referred to as the Postglenoid or Squamosal in this Thesis later on), which corresponds to the extent of this channel.

Streeter states that the vein itself has never been described as persisting, although it exists normally in lower forms as a drainage for the anterior part of the brain into the internal jugular vein.

In an embryo 21 mm. long, Fig. 3 it is found that the Anterior Dural Plexus has annexed itself to the Middle Dural Plexus and drains backward through this newly established channel dorsal to the Otic capsule, (Transverse sinus), A Sagittal Plexus becomes differentiated off, later forming the Sagittal sinus.

The pre-trigeminal portion of the primary head vein remains as the Cavernous Sinus, which retains its communications with the orbit and the pterygoid fossa. It drains back through the lower part of the Middle Dural Plexus - the blood stream being now reversed - in what is now the Superior Petrosal sinus, and through the anastomosis with the Posterior Dural Plexus, which becomes the sigmoid part of the Transverse Sinus. The lower part of the Posterior Dural Plexus remains as the terminal part of the sigmoid portion of the Transverse Sinus, connecting with the Anterior Cardinal vein, which becomes the Internal Jugular vein. The upper part of the Posterior Dural Plexus remains as the Occipital Sinus.

Embryology. Diagrams.

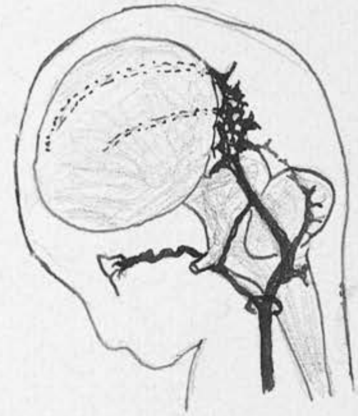


Fig. 4.

50 mm. Embryo.

For enlarged view, See Fig. 7.

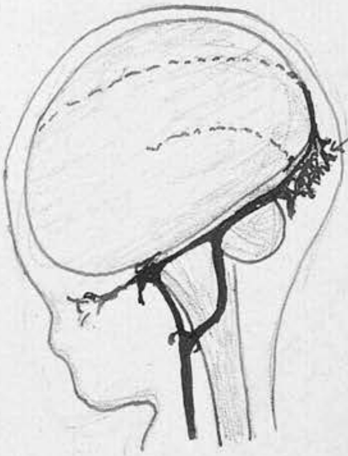


Fig 5.

80 mm. Embryo.

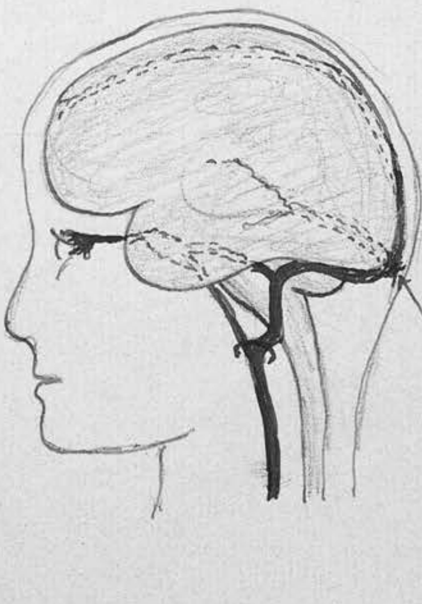
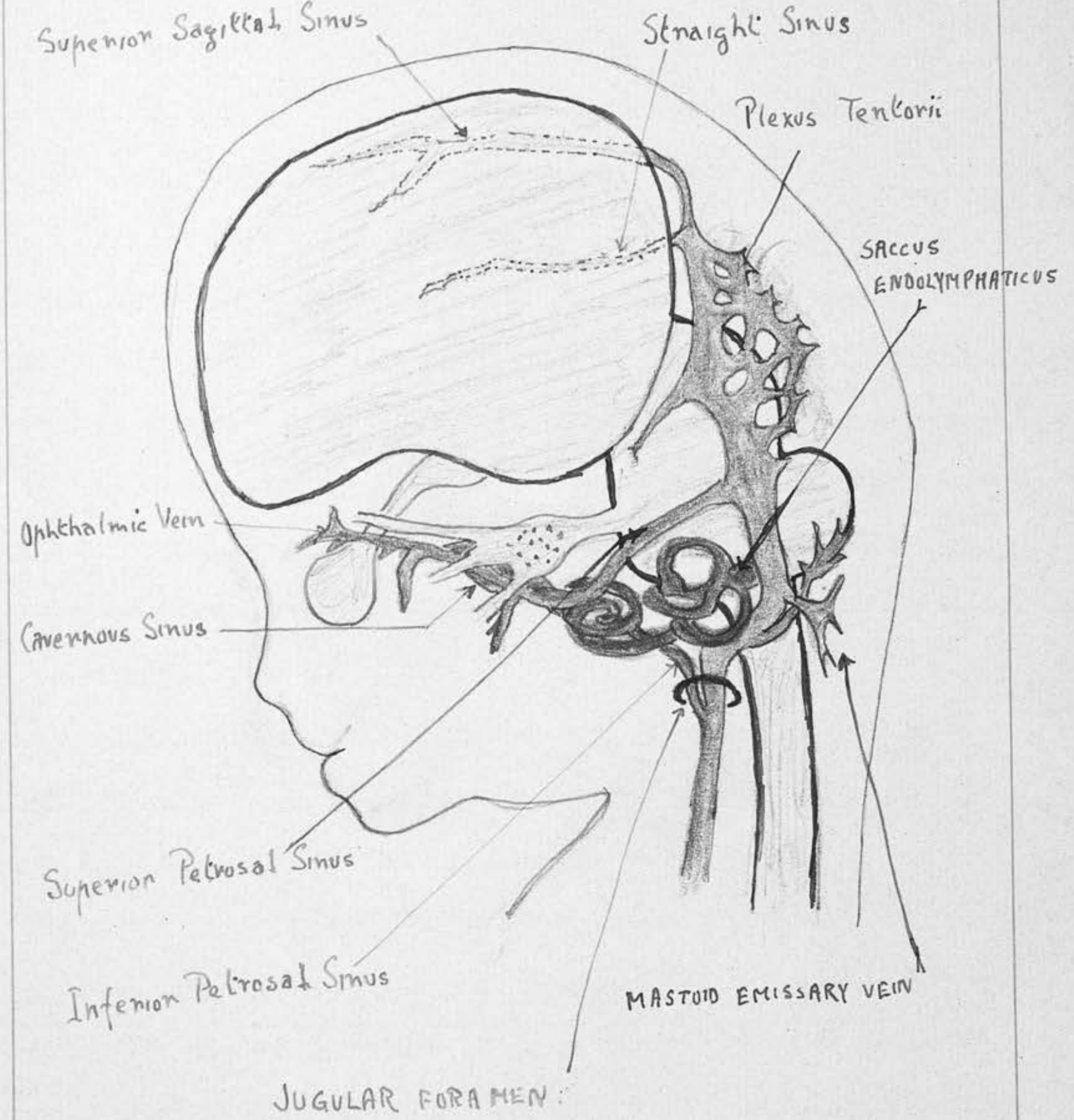


Fig 6.

Adult Type

Embryology. Diagrams.

Fig. 7. Enlargement of Fig. 4. (50 mm. Embryo.)



In an embryo 50 mm. long, the vessels correspond fairly well to the adult channels. It is clearly subdivided into three separate systems: (1) the superficial system belonging to the integument and soft parts, (2) the dural system lying between the dura and bone, and (3) the cerebral system.

All three are outgrowths originally of the same capillary plexus. The superficial vessels are separated off from the dural system by the membranous and cartilaginous cranium, separation first occuring at the base of the skull. A few anastomoses between the superficial vessels and the dural plexus remain as the so-called emissary veins. The mastoid vein is shown in Fig. 7 .

Aside from the channel maintained through the orbit, the chief drainage from the superficial system is through the external jugular vein, which is pictured by Salzer, (1895) as already present in guinea-pig embryos 20 mm. long. Note that it is much later than the primary head vein or internal jugular vein in development, though it is erroneously declared by others to be earlier in development.

The Inferior Petrosal Sinus is a secondary channel, which is found in 50 mm. embryos.

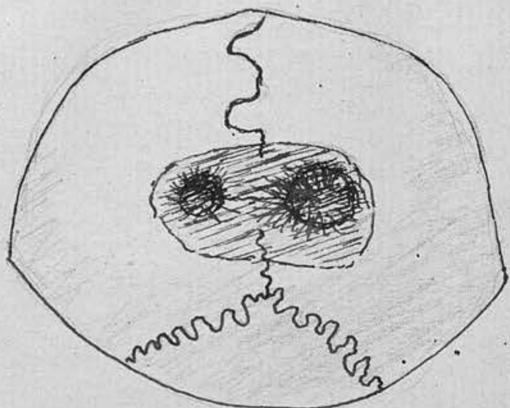
The Sigmoid part of the Tramsverse Sinus is formed first, from the point of entry of the Superior Petrosal Sinus to its termination. The upper portion is only differentiated later from the Tentorial Plexus, which is compressed between the growing cerebral hemispheres and the cerebellum. Interference with this formation would account for one or other part of the Transverse Sinus being small or absent, and being drained by a very large Mastoid foramen. This matter is again referred to later.

From the Tentorial Plexus is also differentiated the terminal portion of the Superior Sagittal Sinus and the Straight Sinus, which terminate in the Transverse Sinus of one or other side. The variations found in the adult in the region of the Confluens Sinuum can be readily understood as variations in channel selection through this tentorial meshwork, (i.e. in the spontaneous backward migration of the Tentorial plexus). The Confluens Sinuum is a remnant of the embryonic tentorial plexus and usually retains a trace of the plexiform character that is found throughout the embryonic stage.

In embryos, Streeter found the Superior Sagittal Sinus going to the right in 89% cases.

Abnormally Large Parietal Foramina.

Fig. 1. Os.G.a.1. (Y.169).

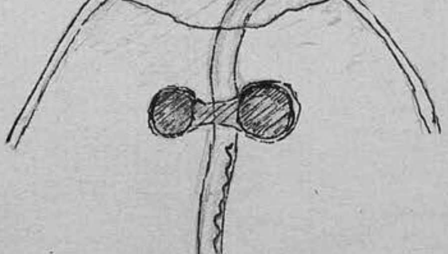


Photograph and Drawing of Posterior Aspect of Calvarium. (Externally).

Internal Aspect on next page, showing a groove on the inner table joining the foramina.

Abnormally Large Parietal Foramina.

Fig. 2. Os.G.a.1. (Y.169).



Views of Internal Aspect of Skull.

81

Abnormally Large Parietal Foramina.

Radiogram of Os.G.a.1. (Y.169).

Abnormally Large Parietal Foramina.

In the Osteology Section of the University of Edinburgh Museum, among the abnormalities, I have found three calvaria showing abnormally large parietal foramina, while the condition was present in one skull in the collection of normal skulls arranged in racial groups, occuring, therefore, once in 1500 skulls.

Os.G.a.1. (Y.)169). See Figs. 1 and 2.

I subjoin the description given in the Museum catalogue, with a few observations added.

"A skull-cap, presenting two rounded apertures in the parietal bone on either side, close to the sagittal suture, and in the situation of the parietal foramina, large enough to admit the tip of the little finger, and occupied by a fibrous membrane belonging to the pericranium. The skull-cap in other respects is well developed."

Both foramina are rounded, the left being 9 mm. in diameter, and the right 15 mm.. The sagittal suture is obliterated opposite the foramina, but is present anteriorly and posteriorly, externally, while internally it is present anteriorly only. The lambdoidal suture shows on both surfaces. The two foramina are joined by a suture, visible on the outer aspect of the calvarium, and the edges are 10 mm. apart, while a point midway between the centres of the two foramina is 30 mm. from the lambda. The suture uniting the foramina is well shown in the Radiogram.

Internally, the groove for the sagittal sinus is seen running backwards to the right side of the median plane, close to the medial margin of the larger, right foramen. The foramina are closed by a fibrous membrane which clearly belongs both to the dura mater and to the pericranium. The edges of the openings are bevelled at the expense of the inner table, hardly at all at the expense of the outer table.

The Radiogram shows more clearly than the photographs or sketches the nature of the openings in the bone, and the suture joining them, which represents the notch or fissure found in most parietal bones at birth. It also shows up the radiate arrangement of the diploic veins in the posterior part of the parietal bone.

Os.G.a. (Y.169a.) See Fig. 3.

This skull has also been described by D.M.Greig in his recent paper on abnormally large parietal foramina. (15).

A skull-cap presenting two symmetrical, elongated, slit-like openings in the parietal bones, close to the posterior superior angle, the right measuring 16 by 5 mm. and the left 12 by 3 mm.. Their long axes are directed transversely with a slight obliquity forwards and laterally, and the posterior margins are somewhat crenated. Externally, the central 32 mm. of the coronal suture is ankylosed. The anterior 50 mm. of the

Abnormally Large Parietal Foramina.

Fig. 3. Os.G.a.2. (Y.169a.)

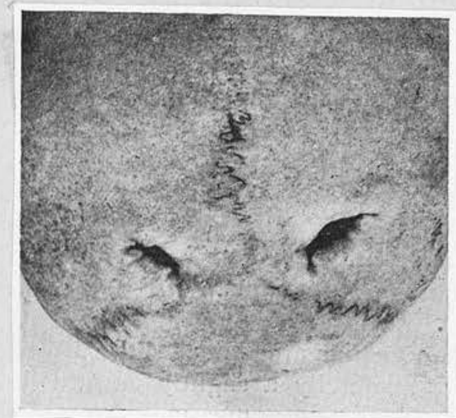


Fig. 4. Os.G.a.3. (Y.117.)

FIG. 4.—Posterior aspect of calvarium from the Anatomical Museum of the University of Edinburgh, showing large parietal foramina and the occipital perforation which transmitted a meningocele.

sagittal suture is obliterated by ankylosis; traces of the suture are then visible over 26 mm., while the posterior 16 mm. is again obliterated. The lambdoid suture is obliterated at the lambda, and for 40 mm. on the left, and 20 mm. on the fight of the lambda. There is a suggestion that the lambdoid suture has formerly communicated with the left foramen. Internally, the coronal and lambdoid sutures are entirely obliterated, but a portion of each limb of the lambdoid is preserved as a linear impression.

The parietal openings are bevelled at the expense of the inner table.

Mesially, the adjacent borders of the foramina are 32 mm. apart, and a point in the middle line opposite their centres is 5 mm. from the lambda, while their posterior ends lie almost opposite the lambda.

The foramina lie nearer the lambda than does the usual situation of the parietal foramina, but this may be accounted for by the fact that an interparietal bone is present and that the true lambda lies more posteriorly.

<u>Os.G.a.3. (Y.117.)</u> See Figs.4,5 and 6.

This calvarium was described by Sir William Turner in 1866, and again by D.M.Greig in his recent paper, (43) and (15). I append the description in the Museum catalogue with some additional notes.

"A skull-cap, presenting three very remarkable gaps in the parietal segment of the vertex; two of

Abnormally Large Parietal Foramina.

Figs. 5 and 6. Os.G.a.3. (Y.117.)

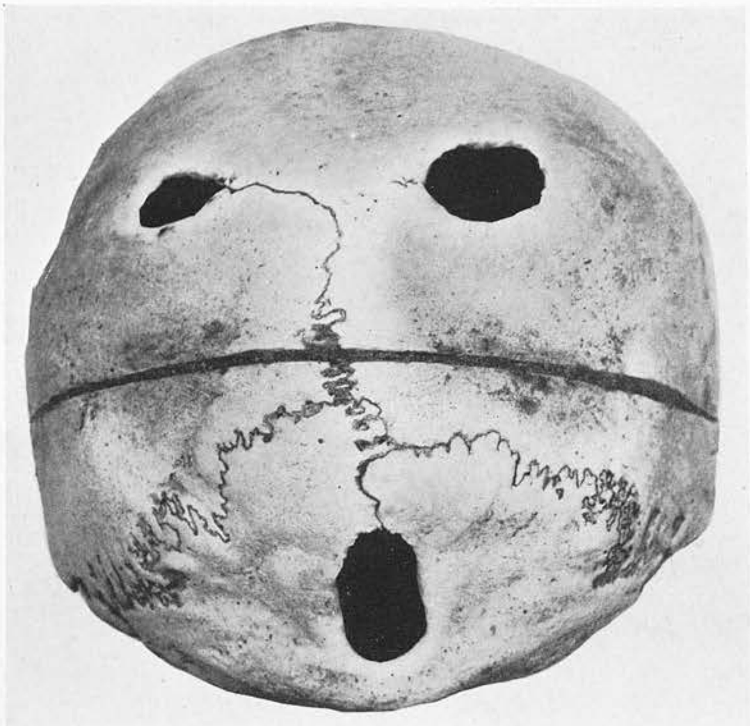


FIG. 5.—Norma occipitalis of the same skull (Fig. 4) to show the relations and true shape of the occipital perforation.

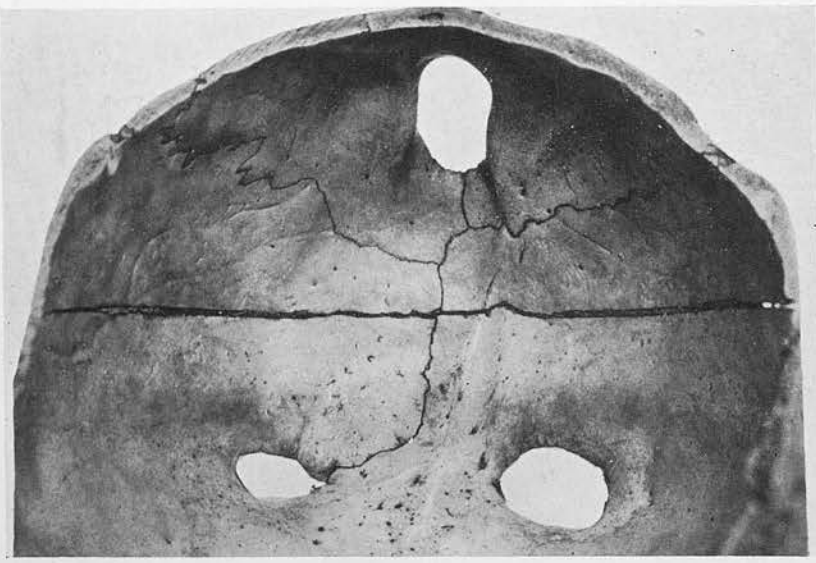


FIG. 6.—Inner surface of skull, showing right deviation of the sagittal sulcus and its continuation to the occipital perforation.

them are situated symmetrically near the upper and hinder angle of the parietal bones, while the third occupies the middle line of the occiput, immediately beneath the apex of the lambdoidal suture. Two of the apertures are large enough to admit the middle finger; they are oval in shape, and the margins are smooth and rounded off. An unobliterated suture runs between the aperture in the left parietal and that in the occipital, crossing the lambda at a right angle. The coronal suture is unusually distinct on the inner surface of the skull. The surface of the outer table is rough and uneven."

The skull-cap was obtained from a woman aged 25, who died after the removal of the Meningocoele which was associated with the gap in the occipital bone, (Maclagan, 30). Both Turner and Greig consider the gap gaps in the parietal bones examples of abnormally large parietal foramina.

The opening associated with the Meningocoele has a vertical diameter of 25 mm., and a smaller horizontal diameter of 14 mm.. Internally, a broad shallow groove passes directly upwards from its upper margin, fading gradually away. The suture crossing the lambda, and running into the occipital opening, lies in the middle of the floor of the groove.

The right parietal opening has its long axis, which measures 21 mm., directed transversely with laterally a slight upward inclination, and a vertical

Abnormally Large Parietal Foramina.

Two Skulls in the Museum of the Royal College of Surgeons, Edinburgh, described by D.M.Greig.

Fig. 7.

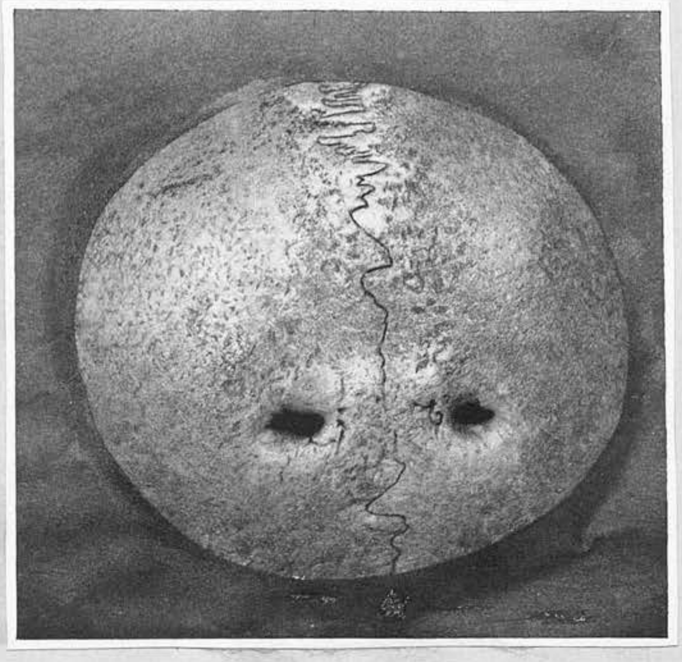
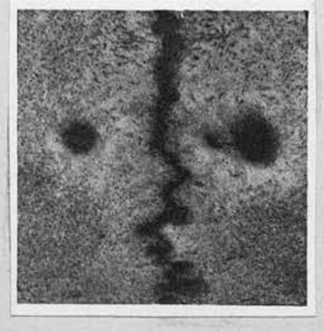


Fig. 8.



Negro Skull.

The second skull (see fig. 8), that of a Negro, has parietal foramina, forming two circular openings, the right being larger and having a mesial offshoot. The left measures 4 mm. in diameter, and the right 5.5 mm. vertically and 5 mm. transversely. From the medial edge of the circumference of the right foramen, a horizontal linear suture passes into a small circular foramen 1mm. in diameter. The outer table slopes smoothly to the circumference of the foramina.

In the Museum of the Royal College of Surgeons, London, there is a skull with parietal foramina large enough to admit the tip of the little finger. Unfortunately, the skull was unobtainable at the time of my visit, and I was unable to see it personally, though I was assured of its existence by the Curator.

Abnormally Large Parietal Foramina.

References in the literature.

Pamperl (34) writing in 1919, stated that only 36 skulls showing this pecularity had been recorded to date and that the abnormality had been observed only five times during life.

Greig (11) was the first to describe the condition during life in 1892, and in 1917 (12), he described a similar peculiarity in the brother of his first case, though mention of this second case was omitted from Pamperl's list.

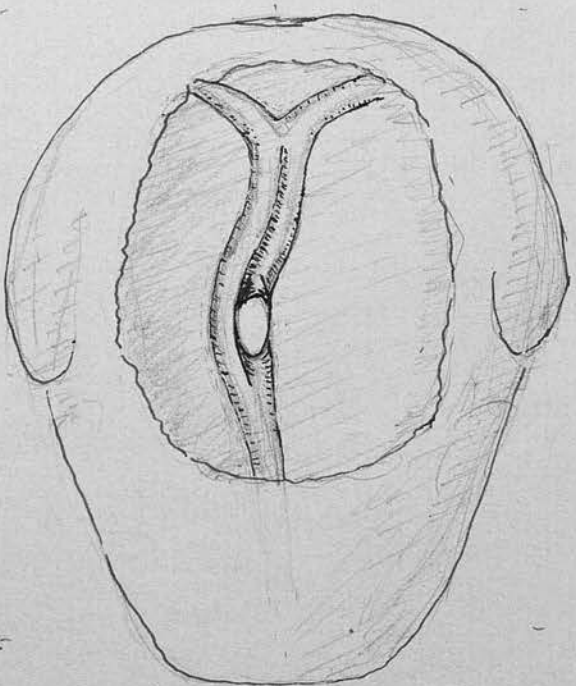
The examples recorded by Maciesza (27) of the defect in two similar skeletons from the same grave suggest a familial defect, while the father of the individual quoted by Symmers (41) "on enquiry was found to have had a similar abnormality," though this is only uncorroborated hearsay evidence.

Unilateral Abnormally Large Parietal Foramen.

Fig. 9. Skull XXIX.D.31.

Posterior Aspect of Skull.

Left Side. Right Side.



Anterior end of Skull.

Drawing, looking through broken base of the skull, into the interior of the calvarium.

Unilateral Abnormally Large Parietal Foramen.

Skull XXIX.D.31.

Enlarged view of Foramen.

Unilateral Abnormally Large Parietal Foramen.

One example was found among the collection of normal crania, with a unilateral wide parietal foramen.

Skull XXIX.D.31. See Fig. 10.

This is a skull from the Northern Territory of Australia. From the cranial characters it appears to be a male skull.

The portions of the occipital bone around the Foramen Magnum have been broken off and are missing, while the interior of the skull is friable so that it is not in a suitable condition to be sectioned. A photograph of the interior is, therefore, not obtainable, but a sketch is appended.

This shows a well-marked groove passing backwards from the foramen to the right side of the median plane to the Torcular (Confluens Sinuum), where it turns to the right to end in the right Transverse Sinus. The Sagittal Sinus runs backwards to the foramen, and divides into two portions, one of which ends at the foramen while the other deviates to the left side of the foramen and runs on to the Torcular, where it bends to the right. This posterior portion of the groove is separated by a ridge from the groove leading backwards from the foramen.

The foramen is oval with its long axis directed vertically, instead of the usual horizontal position, and has smooth margins, bevelled at the expense of the outer table and to some extent the inner table also.

Unilateral Abnormally Large Parietal Foramen. It measures 7 by 4 mm. and is close to the sagittal suture, which actually forms its medial boundary for 2 mm. anteriorly, (the foramen being in the left parietal bone). Its mid-point is 24 mm. in front of the lambda. The sagittal and lambdoidal sutures are well marked. Both Mastoid foramina are absent.

The bevelling is at the expense of both tables.

Greig (15) quotes examples of skulls with unilateral wide foramen described by Lancisci, Le Double (25), Walter, Humphrey (18), and Maggi quoted by Berry (2).

Discussion on Abnormally Large Parietal Foramina.

In only one case among the normal skulls was the Parietal foramen above 2 mm. in bore, so that anything above this may be reasonably considered abnormally large. Among the foramina quoted by Greig (15) and classed as unusually large, are bilateral, equal, circular perforations with a diameter of only 4 mm. recorded by Arnold, and foramina the size of a raven quill mentioned by Wrany. Arnold's case is certainly justified, though raven quill suggests a foramen of 2 mm. or less, which cannot be considered very much out of the ordinary.

In most of the recorded cases, the condition has been bilateral. Greig quotes five cases of "unilateral wide foramen," (already mentioned - Le Double, Lancisci, Walter, Humphry and Maggi quoted by Berry).

Of these Le Double's was a case of asymmetry of the parietal foramina, the left being only a linear cleft, measuring 1 mm., and situated 20 mm. in front of the right, which measured 10 mm. and was circular. Pamperl (34) quotes a similar case from Wrany, where only one of the two foramina was enlarged. One of the cases described by Gruber (17) shows unilateral enlargement, the right foramen alone being affected.

In another of the cases quoted by Greig, that recorded by Humphrey (18), the context is ambiguous, and the presence of both parietal foramina may be meant; indeed, Pamperl takes this view.

The quotation is as follows from Humphrey (18).

"The aperture for the vein that runs through the upper and hinder part of the parietal bone into the longitudinal sinus is, in some skulls, of considerable size. In a specimen in the Cambridge Museum it is large enough to admit the end of the finger".

On the other hand, Humphry (19) mentions a case of unilateral perforation of one parietal bone associated with flattening and thinning of the bones on both sides. Derry (7) describes a similar case in the skull of an Egyptian girl, showing an abnormally wide unilateral foramen in the region of the normal parietal foramen, with flattening and thinning of both parietal bones. The case which Greig recalls of a deficiency in the right parietal bone of a skull described by Maggi and quoted by Berry (2), is really one of a persistent interparietal fontanelle. The skull, that of a child a few months old, showed division of the parietal bone by a horizontal interparietal suture, and the presence of an interparietal fontanelle occupied by an Os Interparietale. A similar condition prevailed in the other parietal bone. No further details are given, and the original reference is not available to the author. This can, however, hardly be classed as an example of an abnormally large parietal foramen, or even of a unilateral foramen.

From this reference to the literature, it will be seen that a unilateral large foramen, such as I have described in the Australian skull, is very rare, much more so than the bilateral large foramina.

Relation of the Foramina to the Parietal Emissary Vein.

In most of the recorded cases it is definitely known that the enlarged foramen was not occupied by an enlarged vein, or certainly that the foramen was not completely filled by the vein, and that the condition in the bone was due to defective ossification. Greig (15) quotes a case described by Bonn in 1783, showing parietal perforation associated with thinning, while similar examples by Humphry and Derry have just beenquoted above.

Indeed, it is difficult to say when an aperture in the bone at the normal site of the parietal foramen, ceases to be an abnormally large foramen and becomes a perforation of the parietal bone. Both names have been given to the same condition by different observers.

The smaller examples recorded may well have contained an enlarged emissary vein, and the relation of the grooves in the interior to the enlarged foramen in the Australian skull described by me, rather suggests that there was a large venous emissary communication between the superior sagittal sinus and the veins of the scalp in this case.

The other skulls, however, tend to show that no important venous anastomosis took place with the superior sagittal sinus, which was very often deflected opposite the foramen, passing alongside it without any sign of communication. The description of Derry's skull confirms this point.

Certain foramina in the recorded cases were known to be closed by a fibrous membrane belonging to dura mater and pericranium, pierced by several minute emissary veins. This is recorded of skull Os.G.a.3 by Maclagan (30) and Turner (43), and by Symmers (41) in the skull which he describes.

In the case of dry skulls, where the membrane was not in position at the time of examination, small vascular grooves have been found in the edges of the foramina.

Maciesza (27), however, records that Bialnicki failed to find any vessel perforating the membrane which closed the abnormally large openings. This confirms the finding in skull Os.G.a.1, which I have described, where the two enlarged foramina are closed by membrane still in position, and apparently not pierced by any vessels. As the edges of the membrane are attached to the bone all round, any shrinking of the membrane would tend to make any aperture present appear larger, rather than smaller, (as in the Obturator membrane), unlike a foetal skull where the moveable bones allow the membrane to shrink down and cause disappearance of apertures present in the fresh condition. One is entitled to assume, therefore, that the membrane was not pierced by any veins during life.

It appears then that there is, as a rule, little connection between an abnormally large parietal foramen and the size of the parietal emissary vein, unlike that seen in the case of the mastoid or condyloid veins.

Nature and Origin of Large Foramina.

In discussing the congenital nature of parietal perforations, both Le Double (25) and Greig (15) state as a diagnostic feature from other openings due to pathological conditions such as intracranial tumour or senile atrophy, the fact that "the bevelling is always at the expense of the outer table and very often of both." In two skulls described here, however, (Os.G.a.1 and 2), the bevelling is at the expense of the inner table, but of the outer, little or not at all.

At the situation of the parietal foramen, there is normally a delay in ossification, and a temporary gap in the bone is present in the foetus - the sagittal fontanelle. This becomes smaller before birth, leaving a narrow cleft or fissure notching the superior border of the parietal bones. I have myself found this cleft in most of the cases in a small number of foetuses, with or without an emissary vein at the lateral end of the fissure. Paterson and Lovegrove (35)found the condition present in 82% of cases, when examining the parietal bones of 85 full-time foetuses. The remains of this original gap normally persist on one or both sides as the parietal emissary foramen of the adult in those persons in whom the foramen is present, that is, in the majority of cases. An abnormally large foramen is simply an exaggeration of this normal deficiency in the ossification of the parietal bone.

Abnormally Large Parietal Foramina.

Greig remarks on the frequency with which the condition is associated with microcephaly, and suggests that it is "a dysplasia where the local cranial result is but a manifestation of a general disturbance apparently limited to bones," evidence of such disturbance in body-growth being found among the examples. The evidence of familial or hereditary occurence of large parietal foramina which he has produced, proves the maldevelopment to be congenital and not dependent on environmental circumstances or individual disturbance of growth. The site of the local result is determined by the normal deficiency in the ossification previously mentioned.

Abnormally Large Mastoid Foramen.

In the collection of normal skulls, there were three which showed large mastoid foramina.

Skull I.B.123., a male, Scottish, showed a right mastoid foramen, the external opening of which measured 7 mm. by 5 mm.. The opening was oblique and the canal very tortuous, so that the bore of the canal was only 4 mm.. Both jugular foramina were large, the left being slightly larger, and the jugular fossae well-marked. The skull was not sectioned, but on examination with a mirror, the internal orifice was not abnormally large.

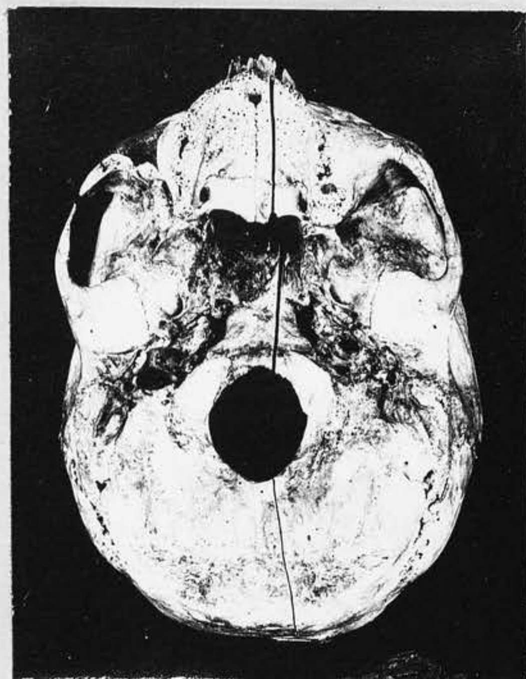
Skull XXII.F.8., a male skull from Borneo, showed a triple opening for the right mastoid foramen, the sum of the openings amounting to 7 mm. - 1.5 mm., 4 mm. and 1.5 mm.. Both jugular foramina were small, but the jugular fossae were present. The skull was not sectioned.

Skull I.B.177., showed a larger mastoid foramen on the left side, which drained the left transverse sinus. The sulcus for the sinus between the mastoid and jugular foramina is absent, the jugular foramen very small and the jugular fossa absent on the same side. This constitutes an abnormally large mastoid foramen. A detailed description is therefore given.

Photographs of the external aspect of the cranial base and of the inner aspect of the left and right halves of the cut skull are appended with sketches bringing out points not shown in the photographs.

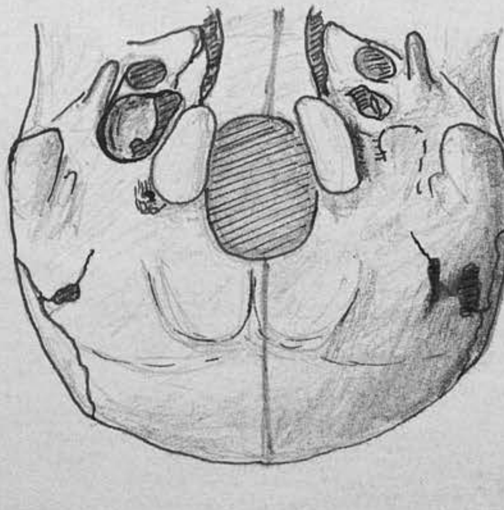
Abnormally Large Mastoid Foramen. (Left).

Skull I.B.177.



Base of skull, showing absence of Jugular Fossa and small Jugular Foramen.

Enlarged Sketch of Base of Skull

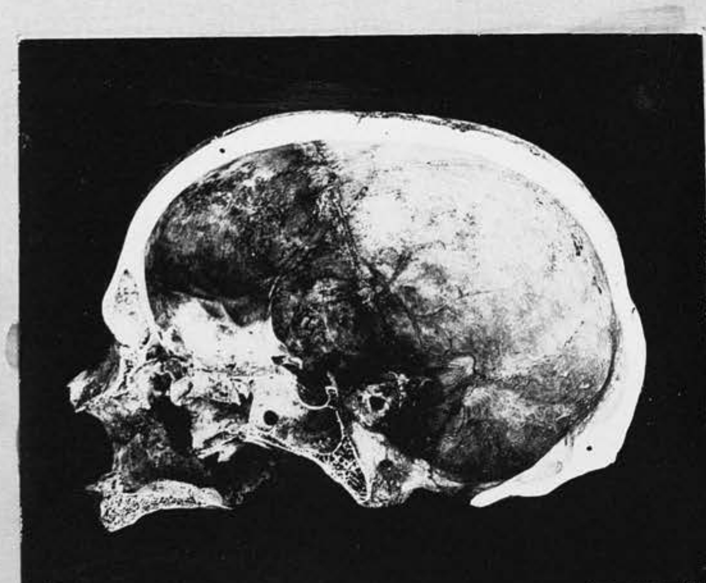


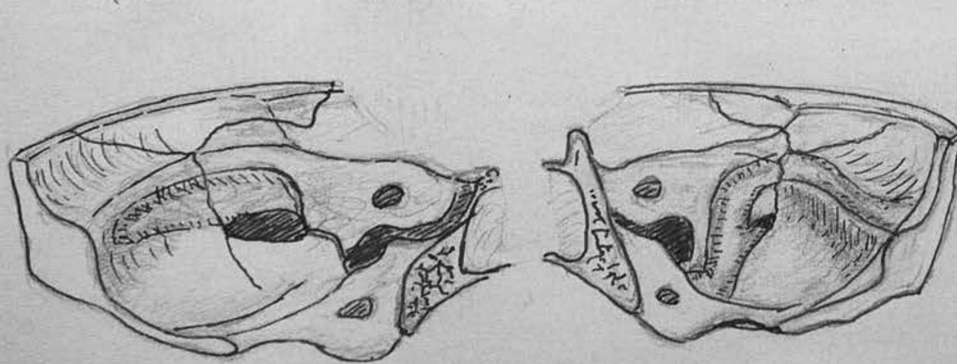
Mastoid Foramen
Sketch of External Openings
on Left Side

Abnormally Large Mastoid Foramen. (Left).

Skull I.B.177.

Views of Left and Right halves of Interior, showing grooves for the Transverse Sinuses.





Abnormally Large Mastoid Foramen. (Left).

Skull I.B.177. Enlarged Views.

External Aspect of Foramina.

Internal Aspect of Foramen.

Abnormally Large Mastoid Foramina.

Skull I.B.177.

A Scottish skull showing male sex characters. Externally the mastoid foramen has two openings, through both of which the mastoid-occipital suture passes. The upper opening measures 8 mm. horizontally by 5 mm. vertically at its widest point. The lower opening lies below the anterior end of the upper and measures from 1.5 to 2 mm.. A groove passes horizontally backwards from the lower opening for 13 mm., the mastoid-occipital suture running in its anterior part. A hair can be passed from one foramen to the other and from each foramen to the interior of the skull.

On the right side of the skull, the mastoid foramen is almost 3 mm. in bore and opens on to the mastoid-occipital suture.

Internally, the left foramen has a large single opening, measuring 13 mm. horizontally by 4 mm. vertically at its widest part. The canal joining the outer and inner openings is short and runs backwards and slightly downwards. The posterior end of the foramen touches the mastoid-occipital suture as it appears on the internal aspect of the skull, so that the upper and larger of the two external openings is almost opposite the posterior end of the inner opening. A hair passed from the lower, smaller external opening and through the inner opening,,in its passage describes the usual S-shaped groove of the mastoid canal.

Abnormally Large Mastoid Foramen.

The groove for the left transverse sinus is smaller than that for the right sinus, which is the continuation of the superior sagittal sinus. The groove on the left side runs forwards as far as the ridge of the petrous temporal bone, bends down for 10 mm. and ends by turning suddenly laterally through the abnormally large mastoid foramen. The terminal part of the transverse sinus groove is represented by a very narrow groove, less than 1 mm. across, running for 25 mm. from the anterior end of the inner orifice of the mastoid foramen to the lateral end of the jugular foramen, the posterior compartment of which is absent. The middle and anterior compartments of the jugular foramen are normal in size. On the right side, the large sulcus for the transverse sinus ends normally. The sketches of the posterior cranial fossae show the differences in the sulci for the transverse sinuses on the two sides.

On the left side, there is a very small petro-squamosal sulcus and a small superior petrosal sulcus leading from the transverse sulcus, but a fairly large inferior petrosal sulcus leads downwards to the anterior part of the jugular foramen. On the right side, there is a small petrosquamosal sulcus and canal of Verga, and a small superior petrosal sulcus, while the inferior petrosal sulcus is small also.

On looking at the base of the skull externally, the left jugular foramen is found to be very small, and the jugular fossa absent. The left occipital condyle is placed more anteriorly than its fellow, and there is a wide groove to the lateral side of the condyle for the enlarged occipital vein. The blood from the left transverse sinus had evidently passed through the large mastoid foramen to the occipital vein and joined the internal jugular vein just outside the skull. The right jugular foramen is large and has well-marked jugular fossa.

The left condyloid foramen is absent, while the right measures 1 mm. in bore.

Both parietal foramina measure .5 mm..

References in the literature.

I have been been able to find seven other recorded instances in the literature. Gruber (16) first described the condition in 1875. In 1903, Laidlaw(23) published the description of an Egyptian temporal bone while Le Double(25) in his book described a skull showing the condition on both sides. Meyer(31) in 1914 described a case himself and quoted one from Merkel. In 1925 Cheatle(4) described two cases among 1500 skulls which he examined in the Museum of the Royal College of Surgeons, London.

As the condition seems to be a rare one, I append brief notes of these recorded instances, for comparison with my own.

Gruber's skull showed a tortuous right mastoid canal, the inner orifice measuring 8 mm. vertically by 6 mm. transversely. Externally the foramen measured 15 mm. vertically and 9 mm. transversely.

Abnormally Large Mastoid Foramen.

This difference in the measurements of the two orifices is noteworthy, and is to be accounted for by the drainage of the posterior temporal diploic vein into the mastoid vein. It is recorded that both jugular foramina are unusually small. Both condyloid foramina were absent.

Laidlaw(23) described an isolated (left) temporal bone of an Egyptian skull, which showed (1) "absence of the internal auditory meatus and stylomastoid foramen and (2) absence of the jugular fossa, and partial absence of the lateral sinus groove in the interior, with presence of a large mastoid foramen."

"The groove for the lateral sinus ends at the mastoid foramen, all the blood being evidently drained by this canal. The sigmoid groove of the lateral sinus is somewhat smaller than usual, and the foramen larger than usual." (No measurement is given, even approximately.) "The superior petrosal sinus groove is present in its normal form, but the inferior is absent."

Le Double in discussing the size of the mastoid foramen, merely mentions that he has a skull with a mastoid foramen on each side measuring 20 mm. in diameter, but gives no further details.

Meyer(31) describes a skull with a large right mastoid foramen. The outer opening, which is on a level with the external auditory meatus, is oval and measures 8 mm. in its long axis. It forms the entrance to a deep tortuous sulcus, which runs diagonally upward and forward through the temporal bone. The inner opening, as in Gruber's case is smaller than the external, and measures 6 mm.. The other mastoid foramen is vestigial.

The jugular foramen is unobstructed.

Meyer also quotes a case described by Merkel, with a mastoid foramen large enough to admit the tip of the little finger, but there is no record as to the side on which the foramen was situated. Merkel ascribed the condition to yielding of the base of the skull due to rickets, with encroachment on the jugular foramen, and compensatory widening of the mastoid foramen.

Cheatle(4) describes two skulls, the first of which I was able to see personally. The second could not be found at the time of my visit, as the skulls were being re-catalogued. I give the Museum numbers.

Skull No. 612.1.

A French skull in which the posterior part is absent.

Both mastoid foramina are abnormally large, the left measuring about 10 mm., and the right about 6 mm.. On both sides the lower part of the lateral sinus groove is absent. The jugular foramina are small and the fossae absent. The mastoid foramina are in the usual position and the grooves for the lateral sinuses become continuous with them, the left groove being the larger. The mastoid canals are tortuous and open externally on to the mastoid-occipital suture.

No parietal foramina present. As the lower and posterior part of the occipital bone is missing, there is no information about the condyloid foramina.

Abnormally Large Mastoid Foramen.

Cheatle's second skull. No. 154.1.

An English skull, showing the left transverse sinus ending half an inch from the jugular foramen, and turning abruptly through a mastoid foramen which opens in the mastoid-occipital suture by an aperture nearly half an inch in diameter(therefore about 12 mm..

On the same side the jugular foramen is small and the jugular fossa is absent.

The other mastoid foramen is one eighth of an inch, and the jugular fossa is present.

There are no other abnormalities.

Discussion on Abnormally Large Mastoid Emissary Foramen.

In Merkel's case, the contraction of the base of the skull on the Jugular foramen was ascribed to Rickets. In Greig's Oxycephalic skull (14), which is described later, (p.132), the base of the skull was narrowed on account of the nature of the deformity, so that both Jugular foramina were small and the Jugular fossae absent. In this case, drainage of the cranial cavity was carried out by mastoid foramina which were somewhat large, and also by a very large occipital ~~and~~ foramen and a squamosal foramen. In Laidlaw's case, there was a primary deformity of the temporal bone, the absence of the Jugular foramen being only one feature.

The enlargement of the mastoid foramen in the foregoing cases was no doubt of a compensatory nature, secondary to the smallness or absence of the Jugular foramen, which was the primary deformity.

In the other cases mentioned, there is no evidence to suppose that a narrowing of the Jugular foramen was the primary cause; in fact in Meyer's case, the Jugular foramen was unobstructed. It is possible that the Jugular foramen in Cheatle's cases may have remained small because the mastoid foramen was large, the sigmoid part of the transverse sinus not developing.

Piersol (36) says:- "The horizontal portion of the left transverse sinus has been observed to be lacking or reduced to an exceedingly fine channel, and one or both of the sinuses have been observed to pass through a greatly enlarged mastoid foramen to open into the posterior auricular vein, the sigmoid sinus being represented only by a very small channel."

Absence of either part of the transverse sinus can be explained embryologically, for the sigmoid portion is formed first, from the anastomosing channel between the Middle and Posterior Dural Plexuses, and the lower part of the stem of the Posterior Dural Plexus, while the horizontal portion is formed at a later date, from the Tentorial Plexus. This anastomosis and separation of plexuses might take place unequally on the two sides, and either portion of a transverse sinus might consequently be small or absent. Should the sigmoid part be absent, the communication between the external and dural venous plexuses forming the mastoid emissary vein would be correspondingly large.

Cheatle (4) in disscussing the etiology of abnormally large mastoid foramen, suggests that it is an atavistic condition, and that in humans the mastoid foramen is vestigial and in the course of time will disappear. This assertion is not borne out by the facts, for the foramen is present in humans in 68% skulls on one or both sides, and while very constant in some animals, is completely absent in others.
In the Anthropoids, particularly the Simians,(which stand next to Man in the zoological scale), the mastoid foramen is certainly less frequently present than in Man. (See section on Comparative Anatomy). p.

Abnormally Large Mastoid Foramen.

Variations in the calibre of the external and internal openings.

In Gruber's skull, the internal orifice was considerably smaller than the external, and the foramen as a whole is not so large as the diameter of its outer opening suggests.

Again in Skull I.B.123., the external opening measured 7 by 5 mm., suggesting an abnormally large foramen, but the bore of the canal was only 4 mm.. This was in part, at any rate, due to the obliquity of the canal in relation to the outer surface of the bone. Other similar cases have been met with.

In Skull I.B.177., on the other hand, the reverse is the case, the inner orifice being the larger.

Part of this difference in the sizes of the two openings is probably due to the fact that the diploic vein empties into the inner part of the canal, draining into the transverse sinus or the superficial veins. This variation in the bore must therefore be considered before deciding on the actual size of the foramen, and classing it abnormally large.

Foramina not usually present.

Emissary Foramina in the Frontal Bone. 116 — 129

Foramen Caecum.

Occipital Emissary Foramen. 130 — 134

Abnormal Foramina in the Temporal Bone. 135 — 143

Postglenoid or Squamosal Foramen.

Emissary Foramina in the Frontal Bone.

Foramen Caecum.

The Foramen Caecum was described by the older anatomists as a blind opening in the frontal bone, as its name implies, but modern text-books, almost without exception, give the impression that it is the usual thing for the canal to be patent and to be traversed by a vein joining the anterior end of the sagittal sinus with the veins of the roof of the nasal cavity.

I have found from personal examination that this latter occurence is quite the exception and I am supported in this finding by Le Double (25), who himself examined personally a large number of skulls.

The information in anatomical and surgical text-books has, no doubt, been copied from book to book, without the author having investigated the fact for himself, so that the information has come to be accepted without question as the orthodox teaching on the subject.

In Gray's Text-Book of Anatomy (10), the Foramen Caecum and its emissary vein is mentioned without any qualification, and in Beesly and Johnston's Surgical Anatomy (1), the Foramen Caecum is said to be traversed by an emissary vein connecting the veins of the nasal mucous membrane with the superior sagittal sinus. Piersol, in his text-book of Anatomy (36), says that the emissary vein is present in childhood, and mentions this as a reason for the epistaxis so frequently met with in children.

In Cunningham's Text-Book of Anatomy (5) under the heading of Emissary Veins, there is found under the subdivision Frontal, "In the child, and sometimes in the adult, an emissary vein passes from the anterior end of the superior sagittal sinus through the Foramen Caecum. Its lower end divides into two channels which either terminate in the veins of the roof of the nasal cavities of they perforate the nasal bones and join the angular veins."

Quain's Anatomy (37) however, says, "It is knowm as the Foramen Caecum, because it is generally blind below, but it may transmit a minute vein from the nasal cavities."

Deaver (6) in his book, does not mention the emissary vein of the Foramen Caecum, but then he does not mention the other emissary foramina, merely emphasising the diploic veins as potent agents of infection to the cranial cavity and blood stream, because of their communications,(some of which are the emissary foramina).

Thompson and Miles (42), in speaking of Infective Sinus Thrombosis quote as an example, "when the superior sagittal sinus is infected from an anthrax pustule of the lip, which has caused Thrombosis of the emissary vein that passes through the foramen caecum," as if this route of spread were a common one among the emissary channels.

None of the authors in anatomical text-books mention where the foramen caecum emerges after leaving the cranial cavity and piercing the cranial wall, but leave the reader in doubt whether the canal they describe, passes through the frontal bone or is simply a gap between the frontal and ethmoid bones when these are articulated..

I therefore give in full a translation of the paragraph on the Foramen Caecum from Le Double's book (25).

Variation in size.

Larger in the new-born than in the adult, this aperture is often filled up in old people.

Variation in Position.

The Foramen Caecum is the commencement of a small canal which penetrates the septum of the frontal air-sinuses, and which goes downwards and forwards towards the root of the anterior, superior nasal spine, at which level it disappears. This canal opens into the frontal sinuses when the separating wall is deficient.

Sometimes, it is prolonged as far as the vault of the nasal fossae, and opens on to one of the small grooves which one sees behind the anterior, superior nasal spine. Very exceptionally, its inferior orifice is situated on the nasal bones, so that it is possible to pass a probe along the Foramen Caecum to the face.

Variation in Content.

One sees, but excessively rarely, the Foramen Caecum traversed by a vein continuous with the lower part of the superior sagittal sinus, and anastomosing, after dividing into smaller and smaller branches, with the veins draining the cavernous tissue of the nasal mucous membrane.

Variations of Structure.

Instead of being entirely in the frontal bone, the Foramen Caecum may be bounded partly by the frontal and partly by the ethmoid. In that case, the Crista Galli presents anteriorly a median groove, on each side of which two hook-like processes project against the frontal and demarcate the canal.

I can confirm the variations given above in regard to postion and structure, and I give details later, but I have not had sufficient material to enable me to make any comment on the size at different age periods. I have found the size subject to great variation; sometimes the foramen is large and deep, while at other times it is quite vestigial.

In regard to the content, I have examined well over a score of bodies in the dissecting-room during the past fifteen months, and in every case, I have found a process of dura mater shaped like a root, filling the aperture. In no case was I able to pass a hair into it from the lumen of the superior sagittal sinus. The superior sagittal sinus gradually tapered off, being formed by the junction of cerebral veins.

Patent Foramen Caecum.

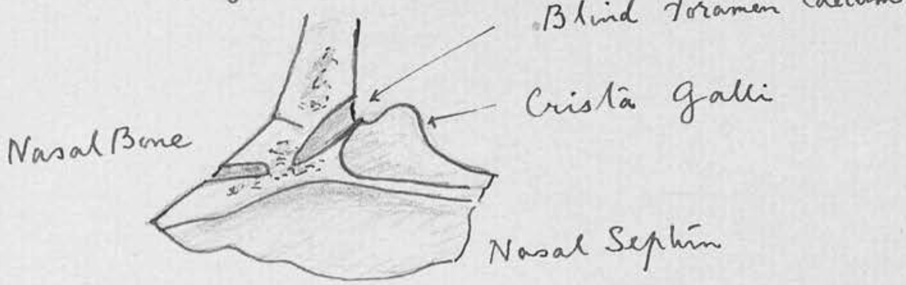
To ascertain the frequency of a patent Foramen Caecum, I examined the interior of 212 crania, and in only three cases did I find a definite canal going right through the bone.

To confirm the absence of the canal, and to investigate the direction of the blind aperture usually present, I removed the bone in the region of the frontal sinus from some skulls from the dissecting room. In a fragment composed of frontal, nasal and ethmoidal bones, sawn in the vertical plane, a blind channel is seen running into the bone from the Foramen Caecum and also from a foramen on the external aspect of the nasal bone. Both blind channels do not quite meet, but end in the diploe at the root of the nose. An osteomyelitis of the intervening diploe might well convey infection from the outer diploic vein to the inner. Such a case shows how a patent Foramen Caecum might arise by vascularisation of the intervening diploe, producing a continuous emissary vein such as the one to be described later. A sketch of the fragment of bone is appended.

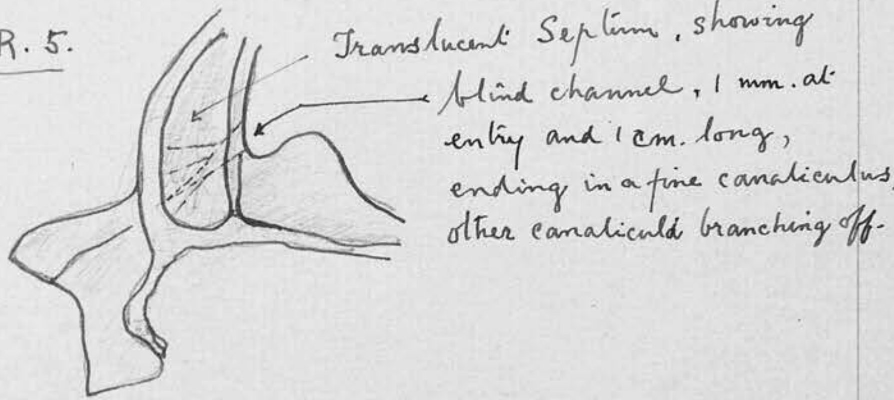
In Skull, D.R. 5., the bone had already been removed so as to expose the left frontal sinus and a very thin translucent septum between the frontal sinuses. The Foramen Caecum was long and gradually narrowed down. A hair passed in could be seen running downwards and forwards to the root of the nose in the translucent septum, until it was held up by the narrowness of the channel, which tapered off finally.

Foramen Caecum.

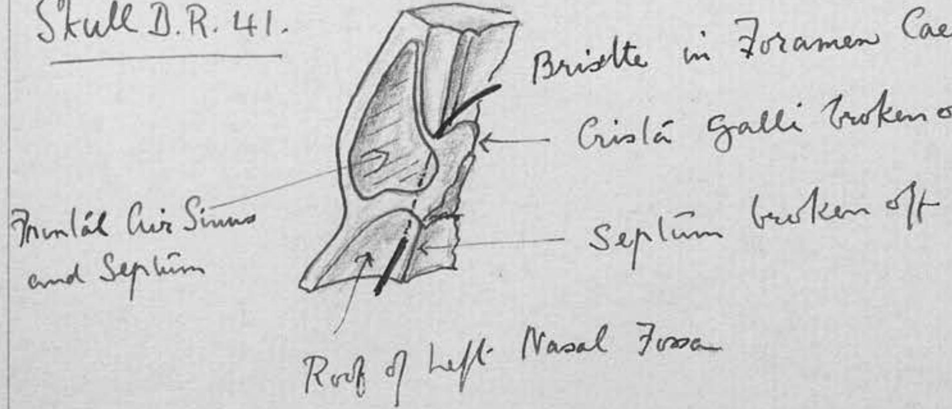
Fragment of Bone; Frontal Region (Left Side)



Skull D.R. 5.



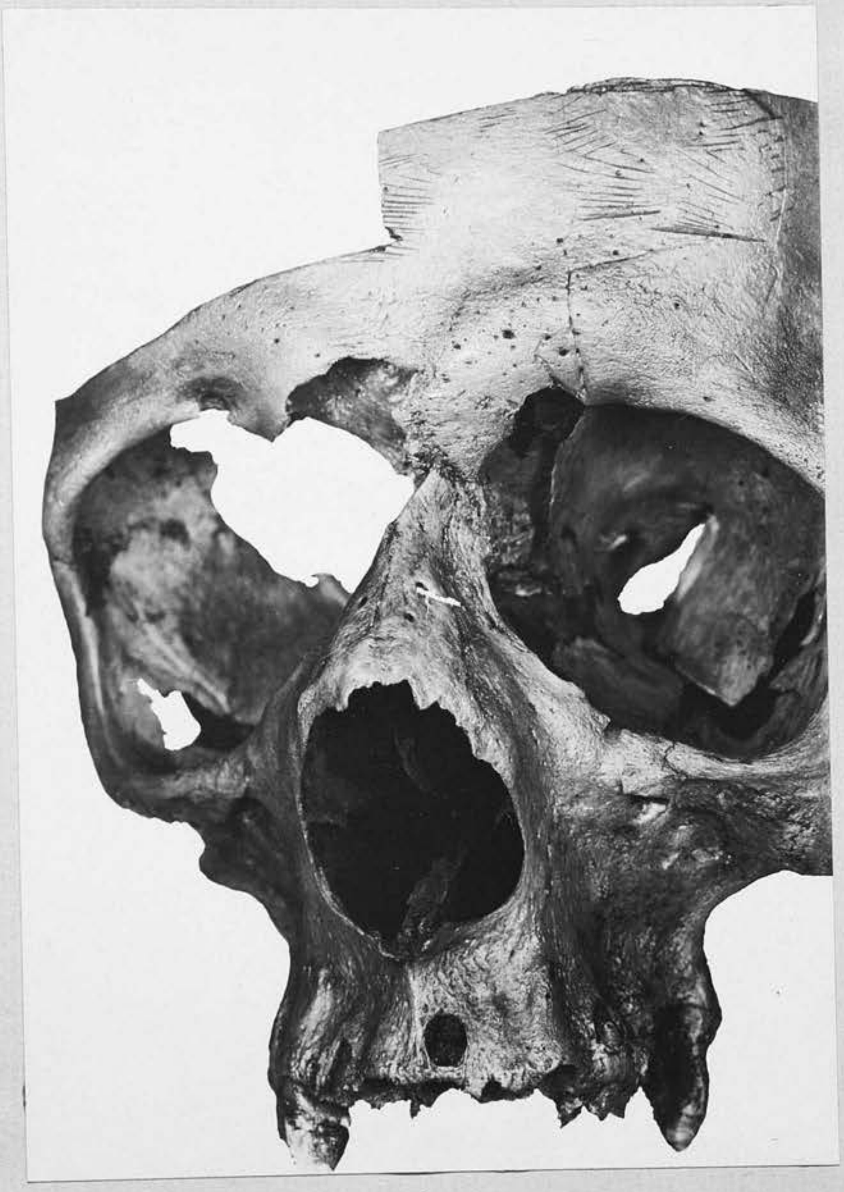
Skull D.R. 41.



Skull D.R. No.18.

Patent Foramen Caecum,

opening on to external aspect of left nasal bone.



From the main blind channel could be seen three or four very fine channels radiating out into the translucent septum. These were no doubt diploic channels. In many cases, therefore, microscopic blood vessels run in the process of dura mater from the diploe of the frontal bone to the anterior end of the superior sagittal sinus. Skull D.R.18.

Of the three skulls in which the Foramen Caecum was patent, the first was a dissecting-room skull, which was damaged owing to the bone of the orbit having been removed during dissection. A photograph is appended, showing a hair emerging from the upper of two foramina on the outer aspect of the left nasal bone. The canal is 3 cms. in length and is very narrow and just admits the hair, the inner aperture being at the Foramen Caecum. It is to be remarked that both vascular foramina of the nasal bone are present, and that there is an extra foramen for the emissary foramen of the Foramen Caecum.

In Skull XIV.5., a very thin hair was passed from the Foramen Caecum to the external aspect of the right nasal bone, the skull having already been sectioned.

In Skull D.R.41., both orbits have been dissected and the central portion of the frontal bone has been isolated with the nasal bones and a small fragment of the ethmoid. The opening of the Foramen Caecum into the cranial cavity, the frontal sinus and the roof of the nasal cavities are exposed and can be seen at the same time. The Foramen Caecum admits a fine hair which passes down in a canal just below the bone of the medial wall of the left frontal air sinus, the septum between the two sinuses, which crosses over to the right of the median plane. The hair is next seen perforating the roof of the left nasal fossa close to the septum, in the frontal bone. A sketch is appended.

Frequency.

A patent Foramen Caecum occured 3 times in 212 skulls, the interior of which could be examined, that is in 1.4%.

If to these are added cases in which the septum between the frontal sinuses was deficient, and a hair passes from the Foramen Caecum into the frontal air sinus or anterior ethmoidal air cells, 8 times, a total is obtained of 5%, but these deficiencies might well have occured after death, so that the existence of an emissary channel in these cases is doubtful.

In one skull, which I obtained from a friend, an abnormal canal was present in the Fromtal Bone, the frequency of the canal being 1:1500 skulls, or .07%, as its existence can be determined without examination of the interior as is necessary in the case of the Foramen Caecum. This skull is therefore described separately, and photographs included.

Abnormal Canal in the Fromtal Bone.

In a skull lent to the author by Dr. T.A.Munro, there is an abnormal canal piercing the squamous part of the Frontal bone.

The skull is that of a female, probably about 25 years of age, the basiocciput and basisphenoid being not yet completely fused. Sex characters are well marked.

The canal, which is 17 mm. in length and somewhat tortuous, has an internal opening in the groove for the Superior Sagittal Sinus, 20 mm. above the Foramen Caecum, while the external opening emerges 7 mm. to the right of the middle line and 5 mm. above the supraorbital margin. At each orifice it admits a probe of 1.5 mm. bore, but such an instrument cannot be passed on account of the tortuosity. The photograph shows a hair passed through the canal.

The groove for the Superior Sagittal Sinus tapers off gradually, and the Foramen Caecum is blind.

The canal probably contained a vein, connecting the Superior Sagittal Sinus with the Angular Vein.

Other Emissary Foramina.

Both Parietal Foramina are absent.

Left Mastoid, 4 mm. bore, opening externally in the occipito-mastoid suture.

Right Mastoid, 1.5 mm. in the suture, with an opening 1 mm., above it in the mastoid bone.

Left Condyloid, 3 mm..

Right Condyloid, 1 mm., tortuous.

Foramen of Vesalius, both slitlike, admit a hair.

Jugular Foramina are normal.

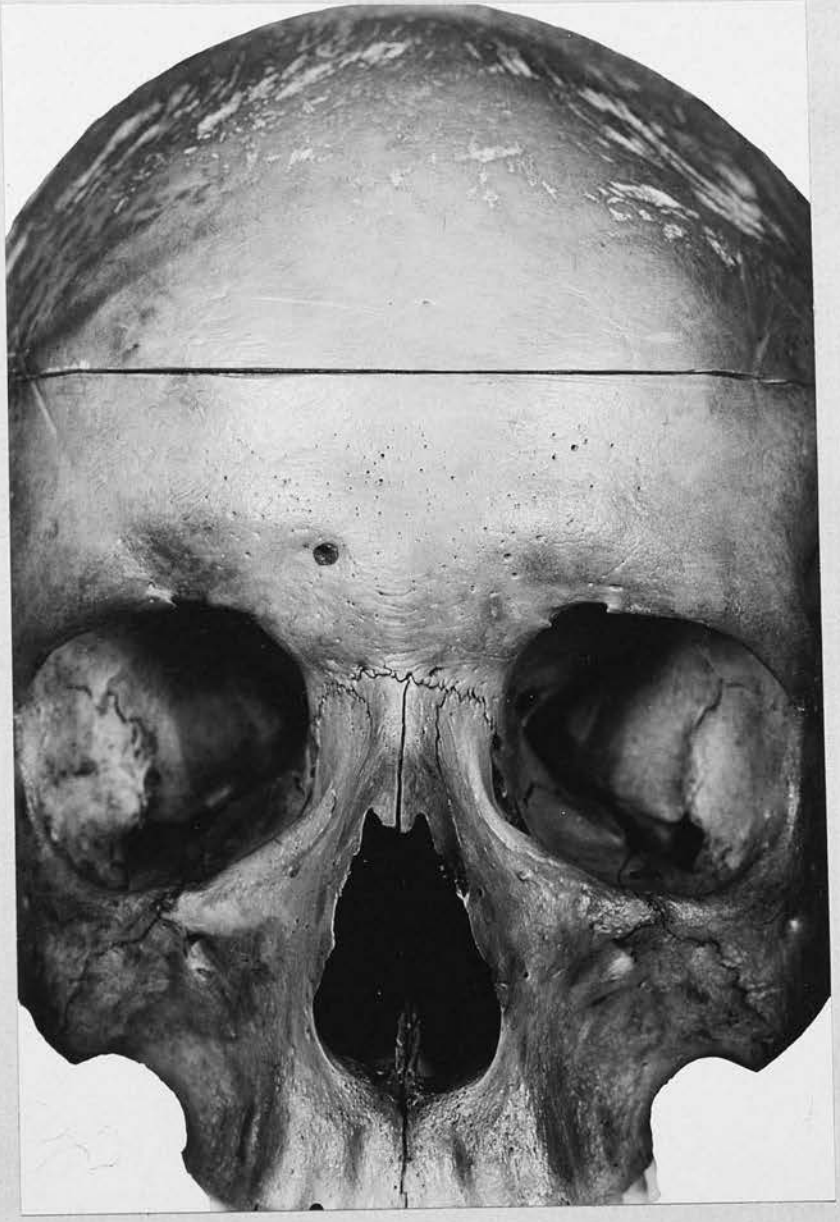
Abnormal Canal in Frontal Bone.

A skull lent to the author by Dr. T.A.Munro.

Note hair passed through the canal emerging from the cranial cavity, (calvarium having been removed).

Abnormal Canal in Frontal Bone.

Enlarged View of the skull.



Emissary Canals in Frontal Bone.

In one skull, No. XXI.B.4., a tunnel leads from the left side of Crista Galli to the vault of the left nasal cavity, and then by another tunnel to the outer aspect of the left nasal bone, through the nutrient foramen, which is larger than usual. While this canal may be for the branch of the naso-ciliary nerve which ends up as the external nasal nerve, it is quite possible that it may be for an emissary vein which joins the lower end of the sagittal sinus.

In some skulls, there are very distinct grooves on each side of the crista galli, which are more likely to be caused by blood-vessels than by the anterior ethmoidal nerve, (branch of the naso-ciliary). If these vessels are the anterior ethmoidal vessels, it is likely, judging from their size, that they form an anastomosis between the intracranial and extra-cranial venous systems. Normally, the anterior ethmoidal artery gives branches to the meninges of the anterior cranial fossa, anastomosing with the anterior meningeal artery, coming from the ophthalmic or lacrimal arteries through the superior orbital fissure. I have not been able to confirm this hypothesis by dissections of injected specimens, but it must be kept in mind as a possibility. Such a communication may be much more important and frequent than that occasionally found by means of the Foramen Caecum, on which undue emphasis is already laid.

Emissary Canals in the Frontal Bone.

Greig (13) in describing a skull showing Hypertelorism, remarks on an opening in the frontal bone as follows:-

"Immediately above the root of the nasal bones is an opening 7 mm. in transverse and 3 mm. in vertical diameter. There is no frontal spine. Though freely communicating with the interior of the skull by its upper half, the lower half of this opening exposes the anterior aspect of the alar processes of the ethmoid. It takes the place of the Foramen Caecum and may have merely contained a process of the falx cerebri and the initial vein of the superior longitudinal sinus. On the other hand, it may be in relation to the anterior neuropore..."

Greig (14) also mentions a frontal emissary foramen in his Oxycephalic skull, situated 30 mm. above the nasion. This skull also showed other abnormal foramina, and is mentioned elswhere in this paper.

Nettleship (32) described a gap during life between the mesial angular process and the frontal process of maxilla "apparently in relation to large veins," in a patient with a deformity of the skull, which Grieg considers Oxycephaly.(14)

Quain (37) in the Bibliography, under the heading Emissary Canals in the Frontal Bone, refers to Italian authors, to whose works I have not had access.

The above facts are sufficient to show that Emissary Foramina in the frontal bone are rare, whether related to the Foramen Caecum, or not.

Occipital Emissary Vein.

An emissary vein in the region of the External Occipital Protuberance, close to or in the middle line, and opening internally into the Confluens Sinuum (O.T. Torcular Hierophili), was present only on 24 occasions divided up among the various races as follows:-

Scottish.	3 cases	1.4%		
European.	3	2.4%		
India.	2	0.9%	Africa	0.
Asia.	4	4.2%	and	
Oceania.	7	4.0%	America	0.
Australia.	5	2.0%		
Total.	24	1.7%		

Size.

On 13 occasions it was 1 mm. in bore.

On 10 occasions it was .5 mm. in bore.

Once it was 2 mm. externally and had two internal openings 1 mm. each.

The foramen was always single, and was situated above or below the External Occipital Protuberance, usually to one or other side of the median plane, all within the radius of a circle of diameter 20 mm.. The canal usually ran obliquely through the occipital bone.

Skull I.B. 176. was sectioned in the median plane vertically, and in the bone exposed were seen two blind channels entering from the external and internal occipital protuberances, running into the diploe, but just failing to meet. Had these blind channels met, an Occipital emissary foramen would have been produced. Many times I met blind channels opening into the interior of the skull at the internal occipital protuberance, and again at the external occipital protuberance, sometimes both being present at the same time, byt without a communication between them. These are the openings of the occipital diploic veins, usually two large openings on each side of and below the external occipital protuberance. A probe can often be passes up for some distance. In addition to these large openings, a number of small, irregular openings are found on each side of the external occipital crest, the vessels occupying them passing into the vessels of the muscles of the back of the neck which are attached to the occipital bone. The condition is very similar to that found in the mastoid portion of the temporal bone.

There are also to be found in some skulls, small foramina in the occipital bone, close to the Foramen Magnum, on one or other side of the median plane, sometimes both. They are present more often than the Occipital foramina described above, ~~and~~ it is possible that they may connect the lower end of the occipital sinus with the sub-occipital plexus of veins, by an emissary vein, or transmit a meningeal branch of an artery.

Sperino (39) claims that he found a well-developed canal in the region of the occipital protuberance,, connecting the external veins with the Torcular or either the left or right transverse sinus in 226 out of 512 skulls, and in 247 skulls canals, some of which permitted the introduction of a bristle though he could not see their internal aperture well. In only 39 cases, does he admit their absence. He notes their anastomosis with the diploic veins, and in 15 injected specimens, found in every case, one or two small venules passing through these canals,

Knott (22) in speaking of the occipital emissary says, "A small vein could be distinctly seen passing through the bone in several cases(six in 44 injected specimens). In most of the others, there was found a small vein in this situation piercing either table of the occipital bone, and anastomosing with the diploic veins between, in this way representing the more distinct communication already mentioned."

In spite of these assertions, I am inclined to think that a true Occipital emissary vein is but rarely present, in round about 2% of skulls. The foramen is small and unimportant when present, and can make very little difference to the venous circulation of the cranium, though it may be important from the point of view of infection. In fact, infection may occur indirectly by the diploic veins without a true emissary vein being present.

The Oxycephalic Skull described by D.M.Greig, (14) shows an abnormally large occipital emissary foramen, 10 mm. in bore., situated above and to the right of the External Occipital Protuberance, and passing obliquely to the left through the bone into the Left Transverse Sinus at the Torcular.

This skull, which I have been able to see personally in the Museum of the Royal College of Surgeons, Edinburgh, has been already mentioned as having an abnormal frontal foramen. The left parietal foramen is absent and the right small. The Mastoid foramen is double and large. There are three foramina in the right mastoid region of large size.

At the base of the skull, however, the foramina are small. Both condyloid foramina are absent. The Jugular Foramen is exceedingly small and there is an absence of any formation of a jugular fossa. On the right side, there are two small openings, there being no real jugular vein, while on the left there are three small openings - the jugular vein having been small.

In addition, there is a large emissary foramen, opening above the root of the right zygomatic arch, to which I shall allude later.

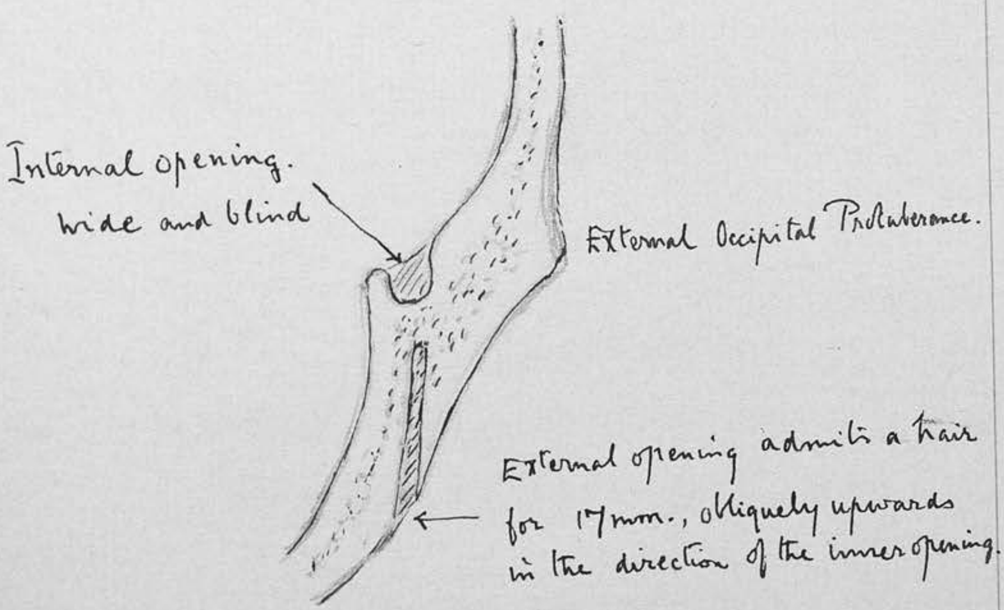
In this skull, there is a reason for the presence of adventitious emissary foramina as the base of the skull is contracted and the Jugular foramina too narrow to drain the venous blood. The communication normally found between the diploic veins and the internal and external veins is wanting as the oxycephalic skull has no diploe.

Reuben and Cleaver, (38) described a large Occipital Emissary Vein in the living subject, a boy with Oxycephaly, so that the same cause was present. Le Double does not mention the Occipital Emissary Foramen or its vein.

The occasional presence of an Occipital emissary vein could be explained embryologically by the persistance of the communication between the tentorial plexus and the external cutaneous plexus at the Confluens Sinuum, the separation occuring late in that area, or in adult life by enlargement and coalescence of the diploic channels opening internally and externally, in the region of the occipital protuberance.

Sketch of Skull I.B.176.

previously mentioned in the text.



Sawn section in region of Occipital Protuberance.

Abnormal Emissary Canals in Temporal Bone.

Postglenoid or Squamosal Foramina.

I have encountered in 8 skulls an abnormal emissary foramen in the temporal bone, either in the lateral end of the petro-tympanic fissure or in the squamous portion of the temporal bone, just above the root of the zygomatic process. The first opening is known in animals as the Post-glenoid foramen, occuring just in front of the external acoustic meatus and immediately behind the mandibular fossa for the head of the mandible (O.T. Glenoid fossa). In the lower animals a post-glenoid tubercle is formed posterior to the fossa and the post-glenoid foramen is found postero-medial to the tubercle.

The second opening Le Double (25) calls the Supra-glenoid foramen. If the foramen is situated further forward in the squamous portion of temporal bone, he suggests the name Squamosal foramen.

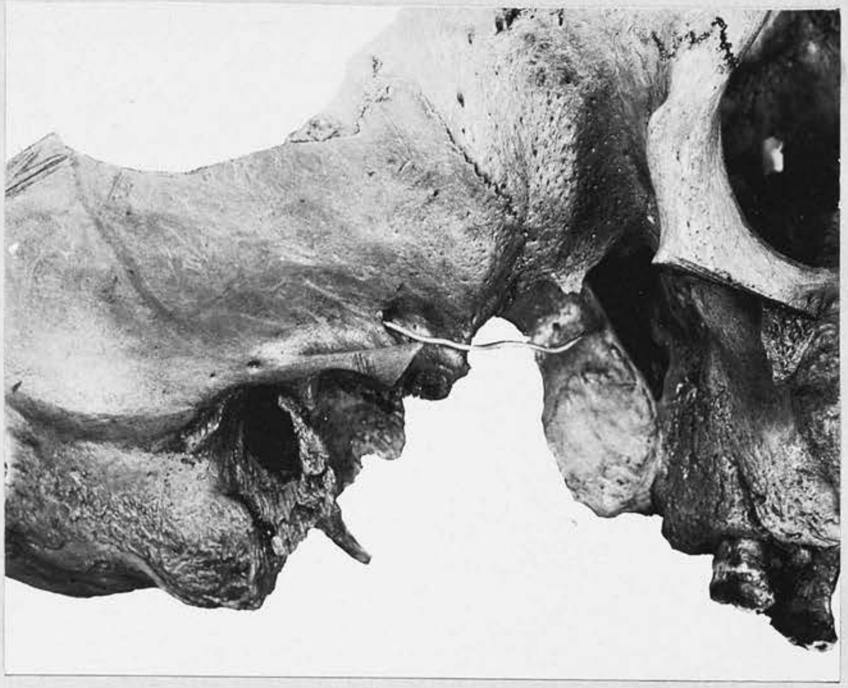
This canal would drain into the External Jugular vein either directly, or indirectly through the Middle or Deep Temporal Veins.

The name Squamosal seems to me more appropriate for the foramen emerging through the squamous temporal, however far forward, the term Post-glenoid being reserved for the foramen emerging between the petrous and squamous portions of the temporal bone. If the name Supraglenoid is omitted, it becomes simpler and there is less confusion.

I shall briefly describe the eight skulls.

Skull D.R. 18., showing Squamosal Canal. (Right)

External Aspect.



Internal Aspect.

1. I.B.92. Scottish. Left Squamosal Foramen.

The left temporal bone is separate from the rest of the skull. A foramen, leading from a vascular groove in the lateral part of the floor of the middle cranial fossa,(petrosquamosal sinus), opens on to the upper and medial side of the zygomatic process externally. Its bore is .5 mm., almost 1 mm..

2. D.R.Skull No.18. Right Squamosal Foramen.

Photographs are given showing a petrosquamosal sinus on the right side which opens into the lower part of the temporal fossa externally, in front of the root of the zygoma, through the squamous part of the temporal bone. The bore is about 1.5 mm. throughout. This is a dissecting-room skull which has been mentioned before as having a patent Foramen Caecum. There is no other abnormality.

The petrosquamosal sinus, though not so frequently present as to warrant mention in an ordinary textbook of Anatomy, is often present in a large number of skulls, sometimes large and sometimes hardly noticeable. Le Double (25) gives a detailed account of the Anatomy and Comparative Anatomy. Knott (22) also describes it and modifications under various names. He found it present in 26 bodies, out of 44, present on both sides in 7 cases, 11 times on the left and 8 on the right. It begins posteriorly at the junction of the horizontal and descending portions of the

Transverse sinus, and runs forwards above the crest of the petrous temporal, then along the petro-squamous fissure to end in the middle meningeal vein, in the Postglenoid foramen, the Squamosal foramen or blindly in a diploic channel in the squamous temporal bone. It may go right on into the orbit through the superior orbital fissure. Sometimes, the canal, instead of running over the ridge of the petrous tempural bone, pierces it, this portion receiving the name of the Canal of Verga. This is the case in the present specimen, Skull No.18, but the photograph does not show it, the hair having slipped out, and lain across the petrous crest.

3. XIII.16. Greek.

Both Postglenoid and petrosquamous sinuses present, emerging in the lateral end of the petro-tympanic fissure, posterior to the glenoid fossa. Left, .5 mm. bore. Right, .5 mm., almost 1 mm..

4. XXI.J.44. India. Right Squamosal.

Right Squamosal foramen only, size .5 mm., emerging in the posterior root of the zygoma, lateral to and behind the mandibular fossa. There is only a faint trace of the foramen on the left side, so that it amy be said to be absent.

5. XXII.F.7. Borneo. Right Postglenoid.

Right Postglenoid foramen only, size .5 mm., emerging in the lateral part of the petro-tympanic fissure, posterior to the mandibular fossa, and posteromedial to a "postglenoid tubercle" just as in monkeys. A trace at most on the left side.

6. XXIX.D.43. Australia. Right Squamosal.

Right Squamosap foramen only, emerging into the floor of the temporal fossa, just above the root of the zygoma, through the squamous portion of the temporal bone, Size, .5 mm., almost 1 mm.. There is only a trace on the left side.

7. XXXIII.B.5. North America. Both Squamosal.

Both Squamosal foramina, size .5 mm. each, emerging posterior to the mandibular fossa, on the lateral aspect of the posterior root of the zygoma.

8. XXXIII.C.2. South America. Left Squamosal.

Left side only, foramen from lateral part of floor of floor of middle cranial fossa to the outer aspect of the posterior root of the zygoma, lateral to the mandibular fossa, bore .5 mm..

Abnormal Foramina in the Temporal Bone.

References in the Literature.

In the Oxycephalic skull described by Greig (14) (p. 132) already described, there was a Squamosal foramen on the right side, opening above the root of the zygomatic process.

Le Double quotes other writers, who give the frequency of the Postglenoid foramen as high as 85%, (Bovero and Calamida), and Lowenstein 9%. The difference Le Double ascribes to the fact that the former writers rightly include the emissary canals opening in the lateral extremity of the petro-tympanic fissure and orifices which one sees now and again in the posterior part of the mandibular fossa. I feel that these openings have been exaggerated, and they are really diploic veins which are normally found in this region. Indeed, Le Double himself draws attention to the diploic veins met here. My own figure works out at .6%, 8 instances in about 1400 skulls. Perhaps, if the skulls had been able to be examined from the inside, a larger number of Postglenoid or Squamosal formaina might have been found. Le Double himself writes, "In 200 Tourangeaux skulls, of either sex, he met a Postglenoid foramen measuring more than 1 mm., nine times(6 times on both sides, twice on the right, and once on the left), The Postglenoid foramen was present in most skulls, but only large enough to admit a hair. The Supraglenoid(Squamosal) foramen was more rare, but he found on the same side in one skull a Supraglenoid foramen 2 mm., and a Postglenoid 3 mm.."

Discussion on Postglenoid and Squamosal Foramen.

I quote from Mall (28) the following statement.

"It is generally believed since the time of Luschka (1865) that the blood from the veins of the brain leaves the embryonic skull through a foramen in front of the temporal bone - the foramen jugulare spurium - and empties into the external jugular vein. A secondary communication is formed with the internal jugular vein, which in man and monkeys is the only outlet of the brain sinuses, both communications remaining open to a greater or less degree in many vertebrates.

Luschka also found a human skull with a foramen jugulare spurium present between the temporal bone and glenoid fossa. This opening is referred to frequently in the various text-books of Anatomy, and it is explained by stating that it is the remains of a channel through which the blood poured in the foetus. This explanation may be correct so far as it goes, but when it is asserted that the brain sinuses at first communicate with the external jugular vein through the foramen spurium and later with the internal jugular vein, a conclusion is drawn which the facts do not warrant."

This explanation is still given in Piersol's Anatomy, (36), and is put forward by Knott (22) and Le Double (25), though it has now been dropped from Cunningham's Anatomy (5).

Streeter (40), (see also section on Embryology, pp.70-78), states "that the foramen jugulare spurium (postglenoid) corresponds to the persistent otic portion of the primary head vein which in the foetus drains into the internal jugular vein," though this persistent portion may later form a secondary communication with the external jugular vein.

This otic portion of the primary head vein, however, runs backwards from the cavernous sinus, whereas the petrosquamosal sinus runs forwards from the lateral end of the horizontal part of the transverse sinus, above and lateral to the ear, to end at the postglenoid or squamosal foramen and usually has no connection with the cavernous sinus.

I have no information concerning the embryology of the Temporal Canal in animals, which is the homologue of the petrosquamous sinus in Man. This canal would have to arise as a secondary formation from the stem of the Middle Dural Plexus at the point where the anastomosing channel to the Posterior Dural Plexus, which becomes the sigmoid part of the transverse sinus, arises, and leave the skull in front of the otic capsule.

Though, to my mind, no adequate embryological explanation has been given for a postglenoid foramen in the human cranium, I think we are entitled to consider it an atavistic condition, a vestigial relic of the Temporal Canal, which is normal in some animals and becomes increasingly rare as we ascend the Primate scale. The occurence of the Postglenoid and Squamosal foramen in animals is referred to in the Section on Comparative Anatomy, which immediately follows.

Comparative Anatomy.

I have examined the emissary foramina in the skulls of 124 Anthropoid Apes and 4 Lemurs. These are tabulated in percentages in the accompanying table and compared with the corresponding figures in Man. The figures represent the occurence of the foramina on one or both sides, and are arranged in columns with the name of the foramen at the top. In the last column, the number of skulls available for examination is given, to show to what extent a comparison can be made between the different groups.

In the lower part of the table, the occurence of foramina on one or other side is noted among the four groups of Simians, Gorillas, Chimpanzees, Orang-Utans and Gibbons.

The Foramen Caecum was found to be represented only by a vestige and was never a patent canal. The nasal slits were relatively large, but had no connection with the groove for the Superior Sagittal Sinus.

The Parietal foramen was always single, when present, and was situated in the median plane, except on two occasions, once when it was on the right side, and once on the left. It was present only once in 74 skulls of the other monkeys, being more common in the Simians, present in 18%. It was not present in any of the 4 Gibbons which I examined, and occured with increasing frequency in Orangs, Chimpanzees and Gorillas in that order, being present in one-third of the Gorilla skulls, which are most like Man in this respect.

Percentage Comparison of Man and Anthropoids.

Foramen present on one or both sides.

	Parietal.	Mastoid.	Condyl.	Postglen.	Avail. Skulls.
Man.	60.5%	68%	77%	0.5%	1478.
Simiidae.	18%	26%	6%	2%	50.
Gorilla.	33%	5%	0	0	18.
Chimpanzee.	14%	0	14%	0	14.
Orangs.	7%	78%	7%	7%	14.
Gibbons.	0	25%	0	0	4.
Other Monkeys.	1%	51%	5%	43%	74.
Total Anthropoids.	8%	41%	5.6%	27.4%	124.
Lemurs.	0	50%	0	100%	4.

Details of Simiidae.

	Parietal.	Mastoid.	Condyl.	Postglen.	Avail. Skulls.
Gorilla.	6 single	1 left	0	0	18.
Chimpanzee.	2 single	0	2(1 pair 1 left)	0	14.
Orangs.	1 single	11(8 pairs 1 left 2 right)	1 left	1 pair	14.
Gibbons.	0	1 left	0	0	4.
Total Simiidae.	9 single	13(8 pairs 3 left 2 right)	3(1 pair 2 left)	1 pair	50.

In addition to the 6 parietal foramina present in Gorilla skulls, there were 4 incomplete parietal openings. Ten of the skulls were male, having 4 complete parietal foramina and 2 incomplete, and 8 of the skulls were female, having 2 complete and 2 incomplete parietal foramina.

The Mastoid foramen was present in 41% of skulls of Anthropoids, a much smaller percentage than in Man. In the Simians, it was only present in 26%, compared to 51% in the other monkeys, and this figure is due to its common occurence in Orangs, 78%. The foramen was absent in the Chimpanzees and only present once on one side in the Gorillas.

The Condyloid foramen was very rare in the Anthropoids in comparison with Man, being present only in 5 5.6% of cases, 6% in Simians and 5% in the other monkeys. It occured twice in the 14 Chimpanzees and incomplete condyloid foramina were present in Gorillas and Chimpanzees.

The Postglenoid foramen, while rare in Man, being present in about 0.5% cases, occurs in 27.4% of the Anthropoids examined. In the Simians, however, it is quite uncommon, occuring in only 2%. It was present on both sides in an Orang, but incomplete foramina were noted at the site of the Postglenoid foramen in 4 other Orang skulls.

Among the Simians, it is to be noted that many skulls have no foramina present at all, 11 out of 18 Gorillas, 8 out of 14 Chimpanzees and 3 out of 4 Gibbons, but only 3 out of 14 Orangs.

Of the Simians, the Gorilla is most like Man in that the Parietal Foramen is more frequently present than in the other members of the series, and the Orang-Utan in that the Mastoid Foramen is more often present. Probably the Gibbon is furthest away from Man in respect of the emissary foramina, but the small number of skulls examined makes this conclusion weaker than the others.

Of the other monkeys, Old World and New World monkeys show no difference when contrasted. The only parietal foramen found, happened to occur in an Old World monkey, but this by itself can be disregarded.

The Parietal foramen is a rarity, the Condyloid foramen occurs about as often as in Simians, but the Mastoid foramen occurs more commonly and the Postglenoid foramen very much more commonly than in the Simians.

I examined only 4 Lemurs, of which 2 had a pair of mastoid foramina and a pair of postglenoid foramina while the other two had a pair of postglenoid foramina alone. The postglenoid foramen was larger than the jugular foramina. Foramina, which seemed to be of an emissary nature were also present in the great wing of the sphenoid, opening on to the floor of the temporal fossa.

<u>Note</u>. Two foramina noted as Parietal, were actually present in the apex of the occipital bone. They drained the Superior Sagittal Sinus, however, and opened on to the skull-cap, but further back than usual.

Comparative Anatomy.

In addition to the Primates, I have examined 160 crania of other Mammals, the results being summarised as follows.

Material.

Carnivora. Fissipedia. Canidae. 32.
and Ursidae,
(75)
14 dogs, 13 bears, 2 foxes, 2 racoons and 1 badger.

Felidae. 26.

6 cats, 1 wild cat, 10 tigers, 3 lions, 2 leopards, 2 pumas, 2 jaguars.

Pinnipedia. Seals. 11.
Walruses. 6.

Ungulata. Perissodactyla. Tapir. 1.
Rhinocerus. 2.
(75) Equidae. 7.

Artiodactyla. Suidae. 17.
pig, boar, peccary.
Hippopotamidae. 6.

Camelidae. 4.

Pecora. 38.
1 giraffe, 6 oxen, 5 sheep and goats, and 26 cervidae of various kinds, deer, elk etc.

Rodents. Rabbits. 6.
(7) Porcupine. 1.

Proboscidae.
Elephants. 3.
(3)

Comparatitve Anatomy.

Parietal Foramen.

The Parietal foramen was found in the Ungulata alone, and when present was single and often in the median plane. I found it twice in the ox, and twice in the camel and once in a rhinocerus. In the hippopotamus there were two apertures in the parietal bone into which a hair passed for some distance, and I could not tell whether they were diploic or true emissary foramina. The skulls were not sectioned, and the interior of the cranium could not be examined by a light and mirror as in human crania. In all the six hippopotami, apertures were present, but in some cases they were undoubtedly diploic.

The Foramen Caecum was not seen in the few skulls which were sectioned.

Condyloid Foramen.

This foramen which was rarely found in Anthropoids, was not present in any of the other Mammalian skulls.

A tunnel is found on the internal aspect of the exoccipital bone, just above the occipital condyle. From an injected dog's skull it is seen that this is occupied by a vein which leaves the cranial cavity by the Foramen Magnum. If this vein pierced the posterior atlanto-occipital membrane and joined the suboccipital venous plexus, it would take the place of the Condyloid emissary vein. I have no evidence on this point, but the tunnel was often present in Mammals.

Comparative Anatomy.

Postglenoid Foramen. (and Squamosal).

This foramen was absent in Rodents and Proboscidae. Among Carnivora, it was absent in all the Felidae and Pinnipedia, and present in all the Canidae and Bears with the exception of the Badger,(only one specimen being examined). It was present in all the Ungulates except the Suidae, Hippopotamidae and the two skulls of the Rhinocerus which were examined.

The foramen was largest in the Cervidae, and in many of them the foramen was only one of a series of terminal openings to the Temporal Canal. Sometimes, there was a single opening situated at the root of the zygomatic process, and no true postglenoid foramen, but transitions were found from the Squamosal foramen to the postglenoid foramen. In the Capybara, a large foramen opened through the squamous part of the temporal bone, and the root of the zygomatic process was pierced by an aperture of like width, so that the emissary vein eventually emerged in the usual position of the postglenoid foramen.

In the dog and bear, the postglenoid foramen is moderate in size, and part of the blood from the cranial cavity leaves by the jugular foramen. Five dog skulls were sectioned and one dog skull was injected with the soft parts in situ. The tentorium cerebri is partly ossified at the periphery, and the transverse sulcus is converted into a bony canal,

Comparative Anatomy.

which begins at the internal occipital protuberance, and runs forwards to the mastoid angle of the parietal bone. Instead of bending downwards, as in the human skull, the main portion of the channel runs forwards and pierces the temporal bone, in the line of the petro-squamous suture, and then turns down and opens at the postglenoid foramen, between the petrous and squamous portions of the temporal bone, behind the mandibular (O.T. glenoid) fossa, and in front of the external auditory meatus, separating it from ~~separating it from separated by~~ the postglenoid tubercle. This is called the Temporal Canal, and corresponds to the Petrosquamous Sinus and the Canal of Verga in Man. In the dog, the canal has not a complete bony septum, and a small sigmoid portion of the transverse sinus runs down to the jugular foramen, and also through a bony tunnel towards the Foramen Magnum. The superior petrosal sinus is small, but the inferior petrosal sinus is large and empties through the jugular foramen.

The venous blood from the hemispheres of the brain drains through the Postglenoid foramen for the most part, while that from the base drains through the jugular foramen.

In the Cervidae, the Temporal Canal is large, and may open at the postglenoid foramen, at the root of the zygomatic process of by one or more openings further forward in the squamous temporal bone. All of these openings may be present at the same time. There is nearly always an opening for a mastoid camal too.

Comparative Anatomy.

Mastoid Foramen.

The mastoid foramen is present in all those animals which have a Temporal Canal, and Postglenoid foramen, i.e., Canidae and Bears (except the Badger), and the Ungulates except the Suidae, Hippopotamidae and the Rhinocerus. I found it absent, however, in the one giraffe which examined, in an ox in a sheep, in an alpaca and a few deer. On the other hand, it was present in two out of 17 Suidae, in probably 3 out of 6 Hippopotamuses, certainly in one Rhinocerus and probably also in the other. It was sometimes large in the horse. In the dog, the foramen was never very large, and the direction of the canal was downwards. In the injected specimen the occipital vein appeared to terminate by traversing it.

The mastoid foramen was completely absent in all the skulls of Rodents, Proboscidae and among Carnivora, of Felidae and Pinnipedia.

Comparative Anatomy. References.

No mention is made of the Foramen Caecum or of the Condyloid foramen in animals, as far as I know.

Parietal Foramen.

Paterson and Lovegrove (35) found the foramen only in the bear, ox and leopard in the skulls in their possesion, but they do not state the number and type of skulls.

Le Double (25) says :-

"There is no mention made of it in the treatises of Comparative Anatomy which I have consulted, and for my own part, I have not found it present in Aves, Herbivora, Carnivora, Rodents or in any monkey. There is no trace of it in a single one of the numerous crania of Anthropoid Apes belonging to the Anthropological Society of Paris. Does that mean that they are always absent in these different animals? No; but they are much rarer than in humans."

Le Double also quotes Ranke, who found a parietal foramen as follows:-

	50 Orangs.		70 Hylobates. (Gibbons)	
On each side,	1	2%	2	3%
On right side only,	5	10%	4	6%
Left side only,	2	4%	0	0
In sagittal suture,	11	22%	4	6%
Completely absent,	31	62%	60	85%

Comparative Anatomy. References.

Le Double (25) gives a full description and discussion on the Postglenoid and Squamosal Foramen, and the Temporal Canal and the relation to the Petro-squamous Sinus in Man.

He found the foramen, which he designates the foramen jugulare spurium, present in Phascolomys and Macropus, and absent in the Phalanger among Marsupials. In the Cetacea, absent in Manatus and the Dolphin. In the Edentates, absent in Bradypus, present in the Anteater. Absent in Proboscidae and Rodents, but it happened to be present in two rabbit skulls, one of which he observed personally. The foramen was present in Cheiroptera and among Insectivora, in the Hedgehog.

It was absent in Hyracoidae.

Among Ungulates, the foramen was very large in size in Bovidae, Ovidae, Antilopes, Stags and Giraffes, moderate in Camels, Horses, the Rhinocerus and Tapir, and absent in Hippopotamidae and Suidae.

Among Carnivora, it was moderate in Canidae and Bears, and absent in Felidae, Hyenas and Seals.

Absent in Simians, moderate in Cebidae and small in Lemurs, among Primates.

Le Double points out the similarity between the Temporal Canal of the New World monkey Sapajou, and the Petrosquamous Sinus and Canal of Verga in Man. His illustration makes this quite clear.

Comparative Anatomy. References.

Mastoid Foramen.

Le Double (25) says:-

"The mastoid foramen is an opening of evacuation which is normally absent in different animals, hares, cats, etc., and which in those which have an intra-osseous lateral sinus is replaced by a canal of the same nature of greater or less length. In the monkeys it may disappear or may be multiple as in the human subject in those species in which it habitually is found. Deniker said that he had failed to find it in a young gorilla. It is absent from the right in an orang and single on the right and double on the left in a chimpanzee in the Paris Museum."

Cheatle (4) says:-

"It seems that, in some animals at all events, the mastoid vein has a share in emptying the lateral sinus, as may be seen in the skulls of the lemur, common dog, dingo dog and horse. In all these a petro-squamous sinus is also present and the lower part of the lateral sinus is absent; the skulls have a very large mastoid vein canal especially in the dog and horse."

In the same paper, Cheatle makes no mention of the Postglenoid foramen, which is vastly more important than the Mastoid foramen, and does actually drain the Transverse (Lateral) Sinus. Cheatle's remarks rather give one the impression that the Mastoid foramen is the main exit of the Transverse sinus and the Petro-squamous sinus too.

Comparison of Man and Animals.

On the whole these preceding facts show that emissary foramina are less common in animals than in Man. While in the human skull, all three pairs of foramina may be present, Parietal, Mastoid and Condyloid, in animals only one set is usually found at one time, and in the Felidae, Proboscidae and Rodents there are no emissary foramina at all.

The Parietal foramen is rarely present except in Simians, which stand next to Man in the zoological scale, and it is always single. It reaches its greatest incidence in the Gorilla, being present in 33% cases, while in Man it is present on one or both sides in 60% cases.

The Condyloid foramen which is the largest and most constant of all the foramina in Man, present in 77% skulls, is still more infrequent in animals than the Parietal foramen, being found in only 5.6% of Anthropoid crania, and not at all in other mammals.

The Mastoid foramen, present on one or both sides in 68% human skulls, is found to vary greatly in its incidence in the different types of animals. It is less commonly present in the Anthropoids, present in 41%, and on further analysis, much less common in Simians, with the single exception of the Orang-Utan, where the foramen is present in 78% skulls.

Completely absent in some mammals, as already mentioned, it is very constantly present in animals with a Temporal Canal, such as Dogs, Bears and most Ungulates.

Sometimes the Mastoid foramen is large in the horse, but it never takes the place of the jugular foramen in draining the transverse sinus and is always smaller than the postglenoid foramen.

The Postglenoid foramen, an aperture rarely met with in Man, in 0.5% skulls, is also uncommon in Simians, 2%, but normally present in many other animals, in 43% of the other monkeys, and very constantly in Dogs, Bears and most Ungulates. In these animals the jugular foramen is small and a greater or less part of the venous blood is diverted through the postglenoid foramen, the proportion varying in the different types of animal.

In contrasting Mammals, two types are found, those with no emissary foramina other than the jugular foramen which alone drains the cranial cavity, and those which have a temporal canal and postglenoid foramen and an accompanying mastoid foramen. Anthropoids provide the transition stage from both those types to the drainage system found in humans, the Simians approximating the human system, the Gorilla in the direction of Parietal foramina, the Orang in the direction of Mastoid foramina, and possibly the Chimpanzee in the direction of Parietal and Condyloid foramina, though this statement must be accepted with reserve owing to the small amount of material examined.

On the other hand, the skulls of certain races show Simian characters, in respect of emissary foramina, as mentioned previously.

Note to Section on Comparative Anatomy, on the Parietal Foramen in Lizards.

It must be remembered that there is a single median "Parietal Foramen" found in certain lizards, such as the New Zealand lizard, Sphenodon (Tuotara), in connection with the Pineal Eye. This aperture, as far as I know, has no vessels traversing it, and is only found in certain lizards, and in no other animals. ?

It must not be confused with the Parietal Emissary Foramen, described in this paper, and apparently little, if at all, known to Zoologists. ?

It does not seem to the author that there is any morphological connection between the two kinds of foramina, and this view is shared by Le Double (25). This note is merely inserted to avoid misunderstanding of terminology, for the name "Parietal Foramen" at once suggests to the Zoologist, the condition found in the lizards.

The Clinical Aspect of the Emissary Foramina.

As paths of infection to the Intracranial Contents, and Skull-Bones.

Infection to the cranial cavity may pass by lymphatics, sheaths of cranial nerves, by emissary veins, and by direct continuity of spread through the bones.

I will confine my attention to spread by the emissary veins, and I refer more particularly to the veins passing through the Parietal, Mastoid and Condyloid foramina.

In this connection, Piersol (36) states that the relation of the emissary veins explains many cases of spread of extracranial infection to the meninges and the sinuses, and he quotes the following statements.

"If there were no emissary veins, injuries and diseases of the scalp and skull would lose half their seriousness."(Treves).

Infected wounds of the scalp, cellulitis or erysipelas involving that structure, osteomyelitis or necreosis of the cranial bones may through the emissary foramina result in serious intracranial disease.

"Pus has formed in the cerebellar fossa outside of the sigmoid sinus, made its exit through the mastoid foramen and appeared as an occipito-cervical abscess." (Erichsen).

Again, "The escape of pus by the mastoid foramen indicates extradural pus in the cerebellar fossa about the sigmoid groove, with the probability that sigmoid sinus thrombosis exists, especially if the mastoid vein is itself thrombosed."(Macewen).

Piersol also states that "in suppurative sigmoid sinus disease the posterior condyloid vein may convey infection to the cellular tissue in the upper part of the posterior triangle, causing abscess beneath the deep fascia; as a result of cerebellar pachymengitis, there may be phlebitis of this vein with marked tenderness in this region."

Thompson and Miles (42) refer to infection of the Superior Sagittal Sinus from an Anthrax pustule of the lip by thrombophlebitis of the vein passing through the Foramin Caecum. This reference and the rarity of an emissary vein traversing the Foramen Caecum have already been noted. (p. 117)

In spite of the fact that spread of infection by means of the emissary veins is referred to in the text books as a not uncommon occurrence, I have found great difficulty in finding references to specific instances where this occurred clinically, while surgeons and pathologists to whom I have spoken cannot recall a case in their own experience.

To approach the subject from another angle, the frequency of occurrence of infective thrombosis of the venous sinuses, the <u>Transverse Sinus</u> is most frequently implicated, and this is accounted for by the fact that infection passes directly from the adjoining middle ear cavity and its prolongations. Infection from the scalp or mastoid region by the occipital and mastoid emissary vein is also a possibility, but I have no information as to its frequency of occurrence.

Friedman and Greenfield (9) described a case in which the mastoid emissary vein was separately and directly the seat of septic thrombosis resulting from infected mastoid cells. During an operation for acute mastoid infection, the vein was exposed and found to be of great size, three-eights of an inch in diameter, and thrombosed without implication of the transverse sinus. The patient had suffered from systemic manifestations similar to those occasioned by thrombosis of the transverse sinus itself. Subsequently the sepsis spread to the transverse sinus, which had then to be opened.

Next in frequency there probably comes thrombosis of the Cavernous Sinus, occurring secondarily to infection of the face, mouth, nose and accessory air sinuses. Here, the infection passes by the Ophthalmic veins from the face and orbit, or by the emissary veins of the Foramen Ovale or Foramen of Vesalius from the Pterygoid and Pharyngeal venous plexuses which drain the mucosa of the pharynx. Turner and Reynolds have made a special study of the paths of infection to the Cavernous Sinus, from the vestibule of the nose(45), and from the nasal cavities and accessory sinuses(46).

Logan Turner (44) mentioned a case recorded by Otto (33), of infective thrombosis of the cavernous sinus, infection having spread from a carbuncle of the neck by the occipital vein, mastoid emissary vein and the superior petrosal sinus.

Langworthy (26) mentions a case reported to him by J.M.Patton, Omaha, Nebraska, of a cavernous sinus thrombosis secondary to a boil on the neck. No information is given as to the site of the boil or the path of infection, but the probabilities are that the boil was situated in the back of the neck, the common site. In this case, as in the last, infection may have spread by the occipital vein and mastoid emissary vein, or, possibly, by the the suboccipital plexus and the condyloid emissary vein. In the same paper, a case of cavernous sinus thrombosis secondary to an infection of the neck is reported by Kanavel, but this may well have been in the anterior triangle of the neck, spread occurring by the emissary vein of the Foramen Ovale or Foramen of Vesalius.

It is probable that in the majority of cases of intracranial complications following infections of the face, such as a boil, anthrax or erysipelas of the upper lip and nose, spread occurs by way of the Ophthalmic veins to the Cavernous Sinus. In the small percentage of people, however, who have a patent Foramen Caecum, such as those recorded on p. 123, infection may pass by the emissary vein traversing it to the superior sagittal sinus.

It must be pointed out that while a non-infective thrombosis of the Superior Sagittal Sinus occurs not uncommonly in subjects of chlorosis or in elderly people with wasting disease, infective thrombosis is apparently rare. One would expect a primary infective thrombosis of this sinus to occur secondarily to an infected scalp wound, infection passing through the parietal foramen, the emissary vein ending in the sinus itself or one of its lacunae or tributaries. (The sinus may also be affected by the spread of the thrombosis from a lateral sinus thrombosis, following otitic suppuration).

On anatomical grounds one would deduce that this primary infective thrombosis would be specially apt to occur if there were pus in the subaponeurotic space - in the loose areolar tissue between the Galea Aponeurotica and the periosteum of the skull-cap, where large quantities of pus can collect. The parietal emissary vein, which begins in the subcutaneous tissue of the scalp and passes through this space to pierce the skull at the parietal foramen, would be tightly stretched between the scalp elevated by pus, and the periosteum, and would be lying bathed in pus. It would, therefore, be very liable to be implicated in the infective ~~thrombosis~~ process, and it is probably on this account that the subaponeurotic space is termed in the surgical text books the "danger area of the scalp". I am not in a position to say how far this theory is supported by clinical experience, for it is possible that it may be merely an anatomical inference without any basis of fact, which has been copied from one text book to another.

Apart from Sinus Thrombosis, other complications have occurred after infected scalp wounds, such as osteomyelitis of the calvaria, meningitis and cerebral abscess. It has been said that osteomyelitis and necrosis of the bones of the skull-cap has been caused by an accumulation of pus in the subaponeurotic space attacking and destroying the pericranium. It is possible, however, that the infection has passed by the emissary veins and through their communications with the diploic veins. Deaver (6) does not mention the emissary veins as pathways of infection, but lays stress on the communications of the diploic veins, and I have already emphasised their connection with the emissary foramina (pp. 57 - 69). This would explain a patchy involvement of the cranial bones, especially at a point some distance from the original focus of infection.

Again, infection might pass by the parietal emissary vein to the meningeal veins or to one of the cerebral veins and so to the interior of the brain, and set up a meningitis or a cerebral abscess without necessarrily causing a massive thrombosis of the Superior Sagittal Sinus itself. A septic embolus might be carried through the parietal emissary vein to the lacuna or tributary of the Sinus in which the vein ends, and from this point a localised retrograde thrombosis might pass along the meningeal or cerebral vein. While this path of infection is open in the majority of people, in a considerable number both parietal foramina are absent, so that the risks of intracranial complications would appear to be lessened in these individuals. This may to some extent account for the fact that in some cases of severe sepsis of the scalp, no intracranial complications followed. The figures for the frequency and size of the various emissary foramina have been given in detail in the appropiate sections of this work.(pp. 22, 31, 44.)

It must be remembered, however, that even where there is no emissary vein visible to the naked eye, infection may still be able to travel by paths which can only be identified by the microscope, and indirect routes by means of the connections of the diploic veins will probably be of great importance. Even so, the larger the ~~the~~ communication, the more likely is it to be a path of infection, and the more speedy will be its progress.

The pathology of the spread of intracranial infection offers a wide field for investigation, and, having given the anatomical facts, I merely state the clinical problem. Before it can be solved, detailed information of clinical cases must be collected and the facts correlated with the postmortem findings.

The Clinical Aspect of the Emissary Foramina.

Relation to the Intracranial Venous Circulation.

The emissary veins are important agents in equalising intracranial pressure, and in conditions of cerebral congestion it would appear that the emissary foramina, with their contained veins can act as safety valves, certain clinical symptoms and signs being thereby produced.

Epistaxis is often met with after fits of crying or coughing in children, there being a temporary rise in the venous blood pressure. In elderly persons, epistaxis is found to occur during an attack of high blood pressure, and frequently gives marked relief to the headache, throbbing and bursting sensations which accompany the condition. In both cases, the epistaxis has been considered to be an overflow from the cranial cavity by way of the emissary vein of the Foramen Caecum. Epistaxis of this nature is very common, while this vein is only rarely present.(See p. 124).

It seems to me unnecessarry to assume the presence of this portal of exit, as the pressure inside the cranial cavity could be equally well relieved by a flow of blood by the emissary vein of the Foramen Ovale to the Pterygoid and Pharyngeal plexuses which are in close communication with the veins of the nasal mucosa.

The application of leeches behind the ear has been practised clinically from time immemorial, and has been said to give relief in cerebral congestion. Apart from the general effect on the blood pressure, there is probably a local effect owing to the connection between the mastoid emissary vein and the transverse sinus, the main drainage channel of the brain.

Similarly, leeches applied to the back of the neck may relieve cerebral congestion directly by means of the connection of the condyloid emissary vein with the transverse sinus inside the skull, and the deep veins of the back of the neck externally. In this case however, a considerable quantity of tissue intervenes between the condyloid emissary foramen and the skin, so that the effect is not likely to be as direct as in the case of leeches applied over the mastoid foramen.

In thrombosis of the transverse sinus, oedema will be prominent over the mastoid process, and in the upper part of the posterior triangle of the neck, owing to the venous stasis in the mastoid and condyloid emissary veins. At the same time, it must be remembered that in acute mastoiditis, there may be considerable oedema which is inflammatory in nature, although the transverse sinus and mastoid emissary vein may be unaffected by thrombotic change. An oedematous swelling of this nature may apparently be found over the site of an extradural abscess situated in any part of the skull, and is known clinically as Pott's Puffy Tumour - an inflammatory oedema. It is

also stated that there

also stated that in thrombosis of the transverse sinus a point of maximum tenderness is found at the exit of the mastoid foramen.

In thrombosis of the superior sagittal sinus, Von Bergmann (3) states "There are no pathognomonic symptoms. Convulsions and bleeding from the nose caused by stasis in the superior cerebral veins and the veins of the Foramen Caecum have been said to be characteristic of this form of thrombosis - Hessler did not find bleeding from the nose or convulsions mentioned in one case of otogenous thrombophlebitis of the superior sagittal sinus. Oedema of the scalp and dilatation of the veins are said to be the usual accompanying manifestations."

This oedema over the vertex can be readily understood as a back-pressure along the parietal emissary vein, but it is not surprising that in some cases it should be absent, for in 40% of skulls the parietal foramina are absent. Judging from the rarity of the emissary vein of the Foramen Caecum, epistaxis should be an uncommon symptom unless there is a generalised increase of intracranial pressure from oedema of the brain following on the thrombosis of the sinus, when the overflow from the cranial cavity would occur by the emissary vein of the Foramen Ovale, as previously noted.

In <u>Oxycephaly</u>, the narrowness of the Jugular foramina has necessitated compensatory enlargement of the emissary veins and the appearance of adventitious foramina. Cases of this nature have been mentioned on pages 129, 132 and 133, by Greig (14), Nettleship (32) and Reuben and Cleaver (38).

In cases of <u>Intracranial Tumour</u> with increased intracranial tension, no enlargement of the emissary foramina has been reported, but there is sometimes marked vascularity of the scalp and skull immediately over the tumour which may prove a source of embarassment during an operation. These changes have also been visible in Radiograms in the form of dilated diploic veins, and there has been in the past a tendency to emphasise the diagnostic importance of these appearances in cases of cerebral tumour.

It is now generally agreed that in cases of increased intracranial tension due to cerebral tumour, no changes at all may be found in the size of the diploic veins. Lewald (24) and Jefferson and Stewart (21) point out the fact that so-called enlarged unilateral diploic veins may occur in normal people, especially in the later decades of life, and emphasise the danger of operating on a supposed case of cerebral tumour on a radiological diagnosis without sufficient clinical evidence. Jefferson says, "In a large series of tumour cases, only occasionally was it possible to establish any notable increase in the size and distribution of the veins. Unusual clarity and breadth of the middle meningeal grooves is more often met with in cases of intracranial tumour."

Elsberg and Schwartz (8) state "that if the diagnosis of brain tumour has been made, and unilateral enlarged diploic channels are found in the general area in which the tumour is suspected, there is considerable probability that the new growth is an endothelioma."

Norman Dott (47) with whom I have had an opportunity of discussing this question, agrees with the cautious statement of Elsberg and Schwartz, which includes the proviso that the clinical symptoms must suggest a diagnosis of cerebral tumour. He has found the radiographic appearances very helpful in many cases. He also pointed out that the increased vascularity was in no way due to venous obstruction caused by the tumour, but affected all the tissues in the immediate neighbourhood ~~of the tumour~~ equally and arose in response to the growth requirements of the tumour. This increased vascularity was noticeable in endotheliomata(mengiomata) and haemangiomata, particularly if the tumour lay close to or in contact with the skull. He has never seen the emissary foramina enlarged in a Radiogram of a patient with intracranial tumour, and in one case where the parietal emissary foramen directly overlay the growth, he was able to expose it at operation and verify the fact that it was not enlarged, by direct inspection. On the other hand, he has seen the bone over the tumour so vascular that an adventitious foramen was present for the passage of vessels, but the arteries were more prominent than the veins.

In Radiology.

In Radiograms, a large mastoid foramen might be shown up and Cheatle (4) in his paper shows a Radiogram of an empty intact skull with a large mastoid foramen.

Where apertures in the bones of the cranial vault are found, the condition of Abnormally Large Parietal Foramen must be remembered, (such as that shown on page 81), and distinguished from deficiencies due to tumours and cysts. Here the clinical features will decide the diagnosis. Greig (15) mentions a case of this nature where the parietal deficiencies were discovered accidentally in a radiographic examination.

Of more practical importance is the normal appearance of the diploic veins, which have been mistaken for fracture of the cranial vault on more than one occasion, as recorded by Lewald (24) and Jefferson and Stewart (21). These writers point out the normal stellate appearance often seen in the parietal region, which is found at a higher level than that usually depicted in anatomical books. This has been reported as "extensive stellate fracture in the parietal region" where there was no injury at all.

The Clinical Aspect of the Emissary Foramina.

In Operations on the Skull, the emissary foramina,,especially if enlarged, may give rise to troublesome haemorrhage. Cheatle (4) points out that mastoid air cells may come up to the mastoid emissary canal above, below and laterally, but never lie medial to it. The emissary vein may, however, be exposed in elevating the periosteum or be wounded in its course as the bone is being removed in the area of operation. Dan M'Kenzie (29) mentions that he met a case in the course of an operation for acute mastoiditis of an enlarged mastoid vein, such as those recorded on pages 102 - 114. In certain cases, the haemorrhage resulting from opening such a vein might be equal in severity to that caused by wounding the tra transverse sinus itself.

In approach to the cerebellar fossa, serious haemorrhage might be encountered if the condyloid foramina were opened, as these foramina are usually quite large, but fortunately there is rarely any necessity to remove bone as far forwards as the occipital condyles. On the other hand, haemorrhage in the region of the external occipital protuberance tends to diminish as the operation proceeds (Jefferson, 21), since the bleeding is diploic in nature. An occipital emissary foramen is rarely met with, (pages 130 - 134), although it is mentioned in descriptions of operations, and it may be that the names "Condyloid" and "Occipital" emissary foramen have been used synonymously by eertain authors.

In operations ofi the vertex, the parietal foramina are not likely to give trouble, as they are usually quite small in size, and when abnormally large, do not appear to be traversed by a vessel of correspondinf size. (pages 98-99).

Summary and Conclusions.

(1) The frequency of occurrence on the left and right sides only, and on both sides of the skull, and the size, of the Parietal, Mastoid, Condyloid Emissary Foramina and the Foramen of Vesalius are summarised individually on pages 22, 31, 44 and 48.

(2) The Condyloid Foramen is the most constantly present of all the emissary foramina, (present on one or both sides in 77% cases), and the largest in size, (bore 1.5 mm. or over in 70%).

The Mastoid Foramen comes next in frequency (68%), and in size (1 mm. or over in 66%), followed by the Parietal Foramen (present in 60%; bore .5 mm. or under in 50%).

The Foramen of Vesalius is the least commonly present (36.5%), and is the smallest in size (bore .5 mm. or under in 65%).

(3) There is no difference in the age incidence of the emissary foramina.

(4) There is no difference in the sex incidence.

(5) Racial Differences.

There is a marked contrast between Australians and other races, especially the White races, in the distribution and size of the emissary foramina.

Whereas in White races, the parietal foramina are more frequently absent than in other races, these foramina are quite common in Australians, and are larger in size, especially as compared with White races.

Median parietal foramina are relatively more common in Australian and New Zealand skulls, especially when compared with White races.

The mastoid foramen is less commonly present in Australians, and when present is decidedly smaller than in White races.

The condyloid foramen is less frequently found in Australians, and is also smaller than in other races.

In 3.5% skulls, there were no emissary foramina present at all. This figure was higher in African races (6.2%), and still more in Australians (7.7%).

(6) These differences in the distribution and size of the emissary foramina in Australians correspond to the arrangement found in the Simiidae, and are probably to be considered "Simian characters".

(7) The Foramen Caecum was definitely patent only 3 times in 212 skulls, the interior of which could be examined, that is in 1.4%. If in addition, doubtful cases are included, this figure is brought up to 5%. Even so, the condition is much less common than the text books would have one believe.

(8) An Occipital Emissary Foramen in the region of the external occipital protuberance was present on 24 occasions, in 1.7% skulls. Cases are quoted where it has been of considerable size.

(9) A Postglenoid or Squamosal Foramen was found in 8 skulls (0.5%). This foramen is normally constantly present in certain animals, but is rarely found in the Simiidae.

(10) Differences in the arrangement of the emissary foramina in Man and Animals were noticed, and a comparison is made on pages 156 and 157.

The Simians appear to occupy an intermediate position between the other Anthropoids and Man, being similar to Man in that the Parietal Foramen is not uncommonly present, although always single, while the Postglenoid Foramen is practically always absent. They tend to resemble Australian skulls in the particulars already noted as "Simian Characters".

These differences may be associated with the difference in size of brain and cranial capacity in Man and Animals. The emissary foramina are on the whole less common in Animals than in Man, and in certain classes of animal they are altogether absent.

(11) Abnormally Large Parietal Foramina may be met with. They are probably due to a defect in the ossification of the parietal bones and are apparently not associated with an enlarged parietal emissary vein. Their existence must be remembered clinically and differentiated from other deficiencies in the skull-cap. There is a large literature on the subject.

(12) Abnormally Large Mastoid Foramina may be met with, and appear to be associated with an enlarged mastoid emissary vein, which may take the place of the Transverse Sinus. One case of Abnormally Large Mastoid Foramen has been recorded with seven other instances from the literature.

(13) There is an important relationship between the emissary foramina and the diploic veins of the skull. There is evidence that they communicate to a greater or less extent in probably the majority of cases.

When the emissary foramen is absent, its place is frequently taken by a diploic opening. In the mastoid region, the posterior temporal diploic vein may have a common orifice with the mastoid emissary vein on the external or internal aspect of the bone. By means of their communications, diploic veins may indirectly become emissary veins.

This relationship is probably of importance in the spread of infection from the exterior of the skull.

(14) Little has actually been recorded of the spread of infection by the Parietal, Mastoid and Condyloid Foramina, but theoretically on anatomical grounds, they would appear to be important paths of infection to the cranium and its contents.

This question deserves further consideration from the clinical standpoint.

(15) Radiologically the Diploic Veins appear to be more important than the emissary foramina, as in the Diagnosis of certain types of Brain Tumour. The normal appearances of these veins must also be remembered before making a Diagnosis of fracture of the cranial vault.

(16) Normally only the Condyloid Emissary Veins are likely to give rise to serious haemorrhage during operations. The Mastoid Veins may, however, do so if enlarged, and in rare cases, the haemorrhage may be as serious as that resulting from wounding the Transverse Sinus itself.

In conclusion, I must express my indebtedness to the interest which Professor Robinson has taken in this Thesis and the kindly advice which he has at all times freely given. It was, indeed, at his suggestion that I investigated this subject, and he has all along accorded me every facility for work in the Museum and Research Rooms of the Anatomy Department of the University.

My thanks are also due to Mr. D.M.Greig, Conservator of the Museum of the Royal College of Surgeons of Edinburgh, and Dr. A.Logan Turner, both of whom are research workers on kindred subjects.

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APPENDIX.

A. Results of examination of injected foetuses.

B, Tables of Skulls in Racial Groups, giving figures of frequency and size of the emissary foramina.

Appendix.

Results of Injection of Foetases.

(1) Injected with Blue Gelatine mixture, into internal jugular vein. Some extravasation of blood had occurred during birth.

Both Condyloids showed up, postero-lateral to the occipital condyle, and a hair was passed through into the terminal portion of the transverse sinus.

Both Mastoids present, the veins passing forwards from the mastoid-occipital suture, piercing the bone about 2 mm. in front, where there was a notch in the mastoid temporal bone, filled by membrane. Hairs were passed into both.

It was not possible to be certain of the presence of the Parietal foramina. There was an appearance of a vessel, in a similar position to the parietal foramen in the adult, from 1 to 2 mm. from the middle line, but it could not be traced through the bone, nor could a hair be passed through it. It appeared to correspond to a narrow notch on both parietal bones.

(2) Internal jugular vein injected with Blue Gelatine and the Aorta injected with red Gelatine. The injection was not so intense as before, but there was no extravasation of blood, (as in the first case), the child having died in spite of an easy birth.

No Condyloid foramina were present, but simply diploic openings at the usual site of the foramina, behind the condyles.

Parietal foramina, not shown up, but the veins of the scalp were poorly injected.
Both Mastoid foramina present. A vein was definitely shown, and a hair passed through. It was accompanied by a branch of the occipital artery, injected with red Gelatine. It took an oblique course forwards from the mastoid-occipital suture.
The Foramen Caecum was blind, and there was no channel visible in the terminal, anterior part of the Falx Cerebri.

(3) Internal jugular vein injected with Blue Gelatine.
Foetus about full time.
Both Condyloids showed up, and a bristle was passed into the transverse sinus. Both Hypoglossal Canals were injected with blue, demonstrating the emissary vein accompanying the nerve.
Parietals. Left present only, but a bristle could be passed through the vessel.
Mastoid. Left side. Diploic openings externally and internally, but no communication. Right side. Internal and external openings communicating with a large space. A bristle passed through the outer opening, penetrated beyond the inner opening, but could be seen crossing it.
The superior sagittal sinus reached as far as the Crista Galli, but the Foramen Caecum was blind.

(4) Full time Foetus, injected with Blue Gelatine.

Condyloids. Left. Diploic opening only.

Right. Admitted a pin easily.

Both Hypoglossal Canals were shown up injected, the right being double.

Parietal. Right present only, but a hair could not be passed through the vessel.

Mastoid. Left, double internal opening, and one large external opening, but no communication.

Right side, none.

The sagittal sinus did not reach the Crista Galli, and the Foramen Caecum was blind.

(5) Full time Foetus, injected with Blue Gelatine.

Condyloids. Left, diploic externally and internally.

Right, foramen present (hair passed).

Parietals. Left, absent.

Right, present (hair passed).

Mastoids. Both present. Both tortuous, passing through the mastoid portion of the temporal bone. In addition, there was a vessel in the left mastoido-parietal suture.

No Foramen Caecum present.

(6) and (7) Two six months twins. Injected with Blue Gelatine.

(6) Both Parietal foramina present. The right parietal bone has a small notch at the edge of the suture. There is no notch on the left side.

(7) Right Parietal foramen allows a hair to be passed through it. A very small left, which does not admit a hair.

In both foetuses, both Mastoids were present.
In both cases, Condyloids were only diploic.
The Foramen Caecum was absent.

In these descriptions, the term "diploic" has been applied to a vascular channel entering the bone, although there is no true diploe till after the age of seven years.

The association of vascular channels in the bone with emissary foramina appears to be similar in the foetus to that found in the adult, in that they are found at the normal sites of the foramina.
Whereas in the adult, the diploid veins of the individual bones of the skull are frequently closely connected with one another, in the child, the vascular channels of each bone do not communicate, the bones being separated by membrane.

Catalogue of Skulls arranged in Racial Groups.

I. British. A. English.

B. Scottish.

C. Irish.

II. - XVII. European. (other races).

II. German.
V.B. Danish.
VI. Swiss.
VII. French.
VIII. Spain.
X. Italian.
XI. Austrian.
XIII. Greek.
XIV. Russia.
XVI. Arctic.
XVII. Turkey in Europe.

XVIII. - XXVI. Asia.

XVIII. Syria.
XIX. Turkey in Asia

XXI. India. A. Bengali.
B. Central India.
D. Southern Provinces.
E. N.W. and Punjaub.
F. N.E. and Nepal.
G. Ceylon.
H. Veddah.
J. Indeterminate.
K. Burmah.
L. Shan States.

XXII. Malaysian. A. Siamese.
C. Malay.
D. Andaman.
F. Borneo.

XXIV. China.

XXV. Japan.

XXVI. Africa. A. North.
B. Central.
C. East.
D. West.
E. South.
F. Negro.

XXVII. Madagascar.

Dissecting-Room Skulls (D.R. Skulls), though not included in the Catalogue, have been included in the lists after I.B., Scottish Skulls.

Catalogue of Skulls arranged in Racial Groups.

XXVIII. Oceania. A. New Guinea.
C. New Hebrides.
D. Solomon Islands.
E. Admiralty Islands.
F. Sandwich Islands and Hawaii.
G. Chatham Islands.
H. New Caledonia.
I. Fiji.Islands.

XXIX. Australia. A. Queensland.
B. New South Wales.
C. Victoria.
D. Northern Territory.
E. South Australia.
F. Western Australia.
G. Indeterminate.

XXX. Tasmania.

XXXI. New Zealand.

XXXII. - XXXIV. American.

XXXII. North America.

XXXIII. South America. A. Peru.
B. Chilian.
C. Patagonian.

XXXIV. West Indian.

For purposes of comparison, the Races have been grouped as follows:-

White Races, (British, (Scottish.
((English and Irish.
(Europeans(others).

Indian.
Asiatics (others).

Oceania.

Africa.

Australia.
New Zealand.

America.

British. English. 1A.

No.	Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
1.	F	-	-	1.5	-	.5	.5
2.	F	-	-	3,2.5	4	-	-
3.	M	-	.5	-	4	-	1.5
4.	M	1	1	.5	2	/	2.5
5.	M	.5	-	1.5	-	-	-
6.	M	.5	1	1	1,.5	-	-
7.	M	-	.5	1	3.5	-	-
8.	M	-	-	-	-	-	-
9.	F	-	1	1	1	-	-
10.	M	.5	-	.5	.5	-	-
11.	M	.5	.5	-	-	-	1
12.	M	-	1.5	-	-	3	3
13.	M	-	-	-	3	-	-
14.	M	1	-	1.5	1	2	3
15.	M	-	-	2	3.5	2	-
16.	M	-	-	.5	1	-	-
17.	M	.5	.5	-	-	-	-
18.	M	.5	1	-	-	-	3
19.	F	-	-	.5	-	1.5	1.5
23.	M	-	2	1	1	1.5	1.5

Note.

When the foramen is not present, the mark "-" is placed in the corresponding column. "/" indicates that the corresponding portion of the skull is not available for examination.

British. Scottish. 1B.

No.	Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
1B.							
1.	M	.5	-	2	3	-	-
2.	M	-	.5	.5	1, 1.	-	-
3.	M	.5	-	2	2	2	2
4.	M	-	.5	1	1.5	2	1
5.	M	-	.5	2	1.5	-	-
6.	F	.5	-	.5	-	2	2
7.	M	1	1	-	2	4	3
8.	M	-	-	1	1.5	-	1
9.	M	-	-	-	2	/	/
10.	F	-	-	2	1.5	3	4
11.	M	1	1	-	-	3	3
12.	M	1	.5, 1,	1	1.5	-	1
13.	M	-	-	.5	/	/	/
14.	M	-	.5	1.5	1	-	-
15.	M	-	1	-	-	.5	.5
16.	M	1	1	-	-	.5	1.5
17.	M	-	-	1	-	.5	.5
18.	F	1	-	2	2, .5,	1,	1
19.	M	-	-	2	2.5	1.5	-
20.	M	-	1	1	-	2	2
21.	F	-	.5, .5,	-	-	3	3
22.	F	1	1.5	1.5, 3,	3.5	.5	-
23.	M	-	-	.5	/	3	3
24.	F	-	.5	1.5, 1,	-	2.5	2.5
25.	M	1	-	-	/	-	-

British. Scottish.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
		L.	R.	L.	R.	L.	R.
26.	F	-	1	1.5	1.5	-	2.5
27.	F	1	1	-	.5	.5	-
28.	M	-	-	-	1.5	-	1
29.	M	1.5	-	1.5	1	-	-
32.	M	.5	.5	3.5	1	/	/
33.	F	.5	-	-	2	/	/
34.	M	-	.5	-	-	/	/
35.	F	-	-	-	-	4	2
36.	M	-	-	.5	1.5	.5	1.5
37.	M	-	-	3	1.5	-	-
38.	F	-	-	-	/	-	-
39.	M	-	-	.5	-	/	/
40.	F	-	-	/	/	/	/
41.	M	-	-	-	-	-	-
42.	M	-	-	-	2.5	.5	.5
44.	M	-	.5	1.5	3	.5	.5
45.	M	-	-	/	/	/	/
46.	M	-	-	-	-	1.5	.5
47.	F	-	.5	-	1.5, .5,	1	1
48.	F	-	-	-	-	/	/
49.	M	-	-	-	.5	-	2
50.	F	-	-	-	-	.5	-
51.	M	-	.5	-	1.5	2	3
52.	M	-	-	/	/	/	/
54.	M	-	-	-	-	-	1.5

British. Scottish.

No.	Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
55.	M	-	.5	-	2	-	-
56.	M	-	-	1	2.5,1.5	1.5	1.5
57.	F	-	.5	-	-	2	-
58.	M	-	-	1	1	1.5	1.5
58a.	F	-	-	1	1.5	1	1
58b.	M	-	-	-	-	.5	1
58c.	M	.5	-	2	1	2	2
59.	F	-	-	/	-	1	1.5
60.	M	-	.5	1, 1	/	/	/
61.	M	1	1	1	-	-	/
62.	M	-	-	2	1.5,1.5	2.5	-
63.	F	-	-	/	-	/	2.5
64.	M	-	-	1.5	1.5	-	-
65.	M	-	-	.5	2.5	.5	-
66.	M	-	.5	2	-	2	-
67.	F	.5	.5	.5	-	2	-
68.	M	-	-	-	-	/	/
69.	M	-	-	/	/	/	/
70.	M	-	1	-	1.5	/	/
71.	M	-	-	-	-	2	-
72.	F	1	.5	1.5	-	-	-
73.	F	1	1	-	-	3.5	3.5
74.	F	-	-	-	-	-	-
75.	F	-	-	-	2	-	1.5
76.	F	-	-	-	/	-	3.5

British. Scottish.

No. Sex.	Parietal.		Mastoid.		Occipital.	
	L.	R.	L.	R.	L.	R.
77. F	1	1	2.5	3	-	-
78. F	.5	-	-	-	-	-
79. F	-	-	1	1.5	-	1
80. F	-	-	/	1.5,1	/	/
81. M	-	-	3	3	/	/
82. F	-	.5	/	/	/	/
83. M	-	-	/	/	/	/
84. M	-	.5	1	1	/	/
85. M	-	1	1	/	2	-
86. M	-	-	1	/	/	/
87. F	1	.5,.5	/	.5	/	/
88. M	-	-	/	/	/	/
89. F	-	.5	1.5	1.5	/	/
90. F	-	-	/	1,.5	/	/
91. F	-	-	-	-	1	-
92. M	-	-	.5	/	-	/
93. M	-	-	1.5	/	/	/
94. M	-	2	-	-	2	2
95. F	-	-	-	/	2	-
96. F	-	-	1.5	1.5	/	2
97. M	-	1.5	/	/	/	/
98. F	-	.5	1,2	1.5	/	/
99. M	-	-	-	-	.5	-
100.F	-	-	-	/	/	/
102.F	-	1	/	/	-	-
103.F	-	.5	/	/	/	/

British. Scottish.

No. Sex.	Parietal.		Mastoid.		Occipital.	
	L.	R.	L.	R.	L.	R.
103.F	-	.5	-	-	/	/
104.M	-	-	-	1.5	-	2
105.F	1.5	1	-	1.5	1.5	2
106.M	-	.5	-	1.5	-	-
107.M	-	-	-	-	/	/
108.F	-	-	/	/	/	/
109.M	-	1	-	-	1.5	2
110.M	-	-	2.5	1	2	1
111.F	-	-	-	-	-	-
112.M	.5 median and .5		-	-	1.5	1.5
113.M	-	-	-	-	1.5	1.5
114.F	-	-	-	-	-	/
115.M	-	-	1.5	.5	-	-
116.M	-	.5	.5	1.5	-	-
117.M	-	-	.5	2	-	-
118.M	-	-	.5	3	-	-
119.M	-	-	1	-	2	-
120.M	-	.5	2	1.5	1.5	.5
121.M	.5,.5	.5	-	-	1.5	-
122.M	1.5	.5	.5	-	1.5	-
123.M	-	.5	-	3·5	3	2
124.F	1.5	-	-	1	/	/
125.F	-	-	2	2	2	1
126.M	.5	-	-	1	2	2
127.M	-	-	2	-	/	/

British. Seettish.

No. Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
128.M	-	-	.5	-	/	/
129.F	.5	1	1	-	-	1.5
130.M	1 median		1	1.5	-	4.5
131.F	.5	1	1.5	-	1	-
132.F	.5	.5	2.5	.5	1.5	1
133.M	-	-	-	-	-	-
134.M	-	-	.5,1	-	3	3
135.M	-	-	.5	.5	1.5	-
136.F	.5 median		-	-	-	2
137.M	.5	1	-	-	-	-
138.F	1 median and .5 R.		1	.5	2	2
141.M	-	.5	-	-	1	2
142.F	-	.5	2	-	2	-
143.M	1.5	1	.5	.5	2	-
144.M	-	-	-	1	-	.5
145.F	-	-	-	.5	-	2.5
146.F	.5	-	1	2	1.5	2
147.F	.5	.5	2	-	2	1.5
148.F	1 median		-	1	3	-
151.M	-	-	1	-	2	.5
152.M	.5	-	-	-	-	3.5
153.M	-	-	1	1	.5	.5
154.M	-	.5	-	1, 1	-	-
155.M	-	-	1.5	1.5,2	/	/
156.F	-	-	-	-	2	2

British. Scottish.

No. Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
157.F	- .5,	.5	-	-3.5	3.5	3
158.F	-	.5	1.5	2.5	2	-
159.F	.5	.5	.5	-	-	3
160.F	-	.5	-	1	/	/
161.F	1	-	-	1,1	1.5	2
162.M	-	-	-	-	.5	3
163.M	-	-	3.5	3,2	-	2.5
164.M-	-	-	1.5	4	-	-
165.M	-	-	1.5	2	-	1.5
166.F	-	-	-	1,.5	-	1.5
167.F	.5	1	-	-	-	2.5
168.M	.5	-	-	-	-	-
169.F	-	-	1	1	3.5	3
170.F	-	-	1	.5	1.5	-
171.F	-	-	-	-	-	3
172.M	-	-	1	-	3.5	3
173.F	-	-	-	.5	2	3
174.M	-	-	2.5	1.5	-	1
175.M	-	1	-	-	1	1
176.M	-	-	.5	1.5	-	-
177.M	.5	.5	6+	2.5	-	1
178.M	.5	-	1.5	1	1.5	1.5
179.M	-	1	.5	-	-	1
180.M	.5	.5	-	4.5	-	-
181.M	.5	.5	-	-	-	-

British. Scottish.

No. Sex.	Parietal.		Mastoid.		Occipital.	
	L.	R.	L.	R.	L.	R.
182.M	-	.5	-	-	1.5	1.5
183.M	-	1	.5	.5	3	-
184.F	-	-	-	-	1.5	2
185.M	.5 median		3.5	3,2.5	/	/
186.M	-	.5	-	-	1.5	1.5
187.M	-	-	2	3	3	3
188.M	1	1	-	-	1.5	-
189.M	-	1	-	-	2	3.5
190.M	.5	.5	-	-	-	-
191.F	-	-	/	-	/	/
192.M	-	-	/	/	/	/
193.F	-	-	-	1.5	-	2
194.F	.5	.5	-	-	3	2.5
195.M	-	1	-	-	-	-
196.M	-	-	/	/	/	/
197.M	1	-	1	-	2	1
198.M	-	-	/	1	/	/
212.M	-	-	1.5	2	1	2
213.F	-	1.5	3	2, 1	/	/
214.M	1	-	-	-	.5	1.5
215.M	-	-	-	/	-	/
216.M	-	-	1	/	/	/
217.F	-	-	-	-	/	/
218.F	-	-	1.5,1	2	3	3
214aF	.5	-	1.5	1	1	2.5

British. Scottish.

No. Sex.	Barietal. L.	Barietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
219.F	-	-	1	-	-	2
220.F	-	-	-	1.5	2	1
221.M	-	-	1.5	2	1	1
224.M	.5	-	-	-	2	-
225.M	-	-	-	-	/	/
226.M	1	1	1	-	-	-
227.M	1.5 median		-	-	-	-
228.M	-	-	-	-	1	2
230.M	-	-	1	1	1	1
231.M	-	1	-	-	1	.5
232.M	/	/	1.5	-	-	-
233.M	-	-	1	1	.5	1
234.M	-	-	-	-	1	1
238.M	-	-	-	-	1	1
239.F	.5	.5	-	-	/	/
240.F	-	-	1	-	-	/
149.M	.5	-	.5	.5,.5	2	2
150.M	-	-	1	-	1.5	-

Dissecting Room Skulls. (Scottish.)

No.	Sex.	Parietal.		Mastoid.		Occipital.	
D.R.		L.	R.	L.	R.	L.	R.
1.	F	.5	.5	-	-	3	4
2.	M	-	-	1.5	1.5	2	2
3.	M	/	/	1.5,2	1,1.5	2	-
4.	M	/	/	1	1	.5	.5
5.	F	.5	.5	-	-	-	1
6.	M	/	/	1,1	-	-	-
7.	M	/	/	1	-	-	2
8.	M	/	/	1.5	-	2	2
9.	M	-	-	1	.5	2	1.5
10.	M	/	/	1	-	2	2
11.	M	/	/	1	1	-	2
12.	M	/	/	1	1	-	1
13.	M	/	/	1	1	/	/
14.	M	/	/	-	-	1.5	1
15.	M	/	/	-	-	-	-
16.	F	/	/	-	-	-	1
17.	M	/	/	1.5	-	-	-
18.	F	/	/	2	1.5	1.5	-
19.	F	/	/	1	.5	2	2
20.	M	/	/	-	1,1	-	-
21.	M	/	/	-	-	1.5	3
22.	M	/	/	4	1.5	-	-
23.	M	-	-	1	1	-	2
24.	F	/	/	-	1.5	3	3
25.	M	/	/	-	-	1.5	2
26.	M	/	/	.5	-	-	-

Dissecting Room Skulls. (Scottish.)

No.	Sex.	Parietal.		Mastoid.		Occipital.	
D.R.		L.	R.	L.	R.	L.	R.
26.	M	/	/	.5	-	-	-
27.	M	/	/	-	-	2	2
28.	M	/	/	1.5	-	-	-
29.	M	/	/	-	1.5	1.5	1
30.	M	1	1	-	.5	2	2
31.	M	/	/	.5	.5	-	.5
32.	M	/	/	1	-	-	-
33.	M	/	/	3.5	3.5	-	-
34.	M	/	/	-	-	-	-
35.	F	/	/	-	-	3	2
36.	F	/	/	-	1	-	1.5
37.	M	/	/	3	-	1.5	2
38.	M	/	/	-	.5	1	1
39.	M	/	/	-	-	2	1
40.	F	-	1	-	1	1	-
41.	M	/	/	2	-	3	2
42.	M	/	/	-	2	2	1.5
43.	M	/	/	-	1.5	-	-
44.	M	/	/	-	1.5	-	-
45.	M	/	/	1.5	-	-	1.5

British. Irish. 1C.

No.	Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
1C.		L.	R.	L.	R.	L.	R.
1.	M	1 median		-	-	3.5	-
2.	F	-	-	-	2	1.5	1
3.	F	-	-	-	-	3.5	1.5
4.	M	-	-	-	.5	1.5	.5
5.	M	-	-	1, .5	1	.5	-
6.	F	.5	-	-	-	.5	-
7.	M	-	-	/	-	/	1
8.	M	.5	.5	1	-	1	1
9.	F	.5	.5	-	1.5	.5	1.5
10.	F	-	-	1.5	4	-	-
11.	M	1.5	-	1.5	1.5	1.5	-
12.	F	1	1	-	1	1.5	3
13.	F	-	.5	-	2	1	1.5
14.	F	-	-	1	1	1	1.5
15.	M	-	-	1.5	1.5	1.5	3.5
16.	F	-	-	1	-	1.5	1.5
17.	M	-	-	.5	.5	-	1.5
18.	M	1	-	.5	-	/	/
19.	M	-	.5	-	-	/	/
20.	M	-	-	-	-	-	1.5
21.	F	-	.5	-	-	1.5	1.5
22.	F	1 median		-	-	.5	-
23.	F	-	-	1	-	-	-
24.	M	-	.5	.5	.5	/	/
25.	F	1 median		-	1	2	2
26.	F	-	.5	1	1	1.5	1.5
27.	M	-	-	-	-	-	1

European. German.II.

No.	Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
II.							
1.	F	-	-	1	-	3.5	2
2.	F	.5	-	-	-	-	1
3.	M	.5	-	-	1	3	3
4.	M	-	-	1	1.5	-	3
5.	M	-	-	1,1.5	1,2	1.5	-
6.	F	.5	.5	1	2	-	-
7.	M	-	-	-	-	-	-
8.	F	-	-	2	1,1.5	-	1
9.	F	-	-	-	-	-	4
10.	F	.5	-	1	1,1.5	1	.5
11.	M	1	-	1.5	2.5	-	-
13.	M	-	1	-	-	2	2
14.	M	-	-	1	1	1	1
15.	M	-	.5	1.5,.5	1.5	1.5	1
Danish.V.B.							
B1.	M	-	-	1	1	1	1
B2.	F	-	-	1.5	1.5	1	-
Swiss.VI.							
1.	M	-	1	-	-	-	-
2.	M	-	.5	1	-	1	1
3.	F	.5,.	1.5,.5	1	2	-	-
4.	M	-	-	-	-	2	.5
5.	F	.5	-	-	-	-	-
6.	F	.5	-	1.5	1.5	-	-
7.	M	-	1	1.5	1.5	.5	1
8.	F	1	-	1,1	2	-	-

European. French.VII.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
VII.		L.	R.	L.	R.	L.	R.
1.	F	1	.5	1,1	1.5	3	-
2.	M	-	-	1.5	-	1	-
3.	F	1	-	1.5	.5	2	-
4.	M	-	-	1	1	1.5	1
5.	M	1	-	1	-	-	-
6.	M	-	1	2.5	1.5	-	2
7.	F	-	-	.5	-	-	-
8.	M	.5	-	1	-	1.5	1.5,1
9.	M	1	.5	-	-	.5	.5
10.	M	-	-	-	3.5	1.5	-
11.	M	-	-	-	-	-	1
12.	F	-	-	1	1	2	-
13.	F	-	-	.5	1	3	4
14.	M	.5	.5	-	-	-	-
15.	F	-	.5	-	.5	-	.5
16.	F	.5	1	1,1.5	-	.5	1
17.	M	-	-	1.5	1	1.5	1.5
18.	M	-	-	3.5	-	-	-
19.	F	-	-	1	-	1.5	-
20.	M	-	-	1.5	1.5	1.5	.5
21.	F	.5	1	.5	-	2	1.5
22.	M	-	-	-	1	1.5	-
23.	M	-	-	1	-	-	-
24.	M	-	-	1.5	1.5	-	-
25.	M	-	-	2	1.5	-	-

European. French.VII.

No.	Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
VII.							
26.	F	-	-	1.5	1	1.5	4
27.	F	-	.5	2	4	-	-
28.	M	. .5 median		1.5	1	-	1.5
29.	M	-	-	2	1.5	1	.5
30.	F	-	-	-	-	2	3
31.	M	-	-	1,1,1	1.5	1	1
32.	F	.5	1	1.5	1.5	4	6
33.	F	-	-	1.5	1.5	1.5	-
34.	F	-	-	1	-	1.5	2.5
35.	F	-	1	-	-	2	2
36.	M	.5	-	1	-	-	1
37.	F	1 median		.5	-	-	-
38.	M	-	-	-	/	/	/.5
39.	F	-	-	1.5	-	1	1
40.	F	-	-	/	/	/	/
41.	F	-	-	1	-	1.5	1.5
42.	F	-	-	-	-	2	1.5
43.	M	-	.5	/	/	/	/
44.	M	.5 median		1.5	1.5	-	1
45.	M	-	1	.5	.5	2	2
VIII.M		-	-	.5	.5	-	-
(Spain.)							
X.1. M		.5	-	1	-	2	1,1
(Italian.)							
X.2. M		-	-	/	2	/	/
XI.1.M		.5	1	-	-	-	-
(Austrian.)							
XI.2.F		.5 med, .5r		-	1.5	1.5	1.5
XI.3.F		-	1	1.5	1.5	3	3.5

European. Greek. XIII.

No.	Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
XIII.							
2.	F	-	-	-	-	1	1
3.	M	.5	.5	-	2	/	/
4.	F	-	-	1.5,1	1,1	/	/
6.	M	-	-	/	/	1.5	1.5
7.	F	-	-	-	-	1	1.5
8.	M	-	-	-	1	2.5	1.5
9.	M	.5	.5	.5	4	-	-
10.	M	-	-	-	-	/	/
11.	M	-	.5	-	-	3	4
12.	M	-	-	1	1	/	/
13.	M	-	.5	-	-	-	-
14.	M	-	-	.5	.5	/	/
15.	M	-	-	-	-	1.5	1.5
16.	F	-	1.5	.5	-	2	2
17.	M	.5	.5	-	-	1	1
18.	M	.5	-	1	1	1	1.5
19.	M	-	-	2	1	1	1
XIV. Russia.							
1.	M	.5	.5	.5	.5	-	-
2.	M	.5	-	3.5	-	-	4
3.	M	-	.5	1.5	-	-	4
4.	F	-	-	-	-	-	-
5.	M	- -	- -	- -	-	-	.5
6.	F	-	-	.5	-	1.5	-
7.	F	.5	.5	.5	1	1.5	3
8.	M	-	.5	1.5,.5	1,1	2	1
B1.	M	-	.5	-	-	1.5	2

European. Arctic. XVI.

No.	Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
XVI.		L.	R.	L.	R.	L.	R.
A1.	F	1.5	-	1,1	1	1.5	1.5
A2.	M	-	.5	-	-	-	-
B1.	M	-	-	.5	1	1.5	1
B2.	F	.5	.5	-	1	3	3
(C.	Esquimaux.)						
C1.	M	.5	1.5	1.5	/	2	1.5
2.	M	-	-	1	1.5	.5	3.5
3.	M	.5	-	.5	-	1.5	-
4.	M	-	-	.5	1	1	1.5
5.	M	.5	.5	1	1	-	-
6.	M	.5	-	-	1	-	.5
7.	F	-	.5	.5	1	1.5	-
8.	M	-	-	-	-	-	-
9.	F	-	-	-	-	2	1
10.	F	-	-	1,1	1	2	1
11.	F	-	.5	-	-	1.5	1.5
12.	M	.5	.5	-	-	1	3.5
13.	M	.5	-	-	1.5	3	3
14.	F	1.5	-	-	2	1.5	1
15.	M	1	-	.5	1	1	1.5
16.	M	1	1	.5	.5	1.5	1.5
17.	M	-	-	-	-	.5	.5
18.	M	-	.5,.5	-	1	3.5	3.5
19.	F	.5,.5	-	.5	.5	1	-
20.	F	-	.5	.5	-.5	-	2
21.	F	.5 median		-	.5	1.5	1.5
22.	M	-	-	1	2	-	-
23.	F	-	.5	.5	.5	-	1.5

Turkey in Europe. XVII.

No.	Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
XVII.							
1.	M	-	1	1.5	2	3.5	-
2.	M	-	-	1	-	1.5	1.5
3.	M	-	.5	-	1.5	.5	-
4.	M	.5	.5	-	-	.5	-
5.	F	-	-	1.5	1	-	-
6.	F	-	-	1.5	-	-	-
7.	F	.5	-	-	-	3	1.5
8.	F	-	.5	.5	1.5	.5	1.5
Asia XVIII. Syria.							
1.	M	-	-	-	-	1	-
2.	F	-	-	-	-	3	1.5
3.	M	-	-	-	-	-	-
4.	M	.5	1,1	-	1	-	2
5.	F	-	-	1	1	1.5	3
XIX. Turkey in Asia.							
1.	M	-	-	-	1.5	1	3.5
2.	M	.5	1	-	.5	.5	2
3.	F	-	-	.5	1	1.5	1
Asia. India. XXI.A. Bengali.							
1.	M	-	-	-	-	/	/
2.	F	1	.5	-	-	1	1.5
3.	M	.5	1	1.5	-	3.5	4
4.	F	1	1	-	3	3	3.5
5.	F	-	-	-	1.5	.5	2
6.	F	-	-	1	-	-	2

Asiatic. India. XXI.A.Bengali.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXI.A.		L.	R.	L.	R.	L.	R.
7.	F	-	-	-	1.5	-	1.5
8.	F	-	-	-	1.5	-	1.5
9.	M	-	.5	1	1.5	2	.5
10.	F	.5	.5	.5	.5	1	/
11.	M	.5 median		-	-	2	3
12.	M	.5	1	1	.5	1.5	1.5
13.	M	-	-	-	-	-	3
14.	M	1	.5	1	-	3	.5
15.	M	-	-	1	-	-	1.5
16.	F	-	-	-	1	1	1
17.	F	1	-	1	.5	2	2.5
18.	M	1	.5	-	-	3	3
19.	F	.5	.5	.5	.5	3.5	-
20.	F	-	.5	1,1	1,1.5	2	-
21.	M	.5	1	-	-	1.5	3
22.	M	1,1	-	-	-	2	4
23.	F	1	-	-	-	-	-
24.	M	1	.5	-	1	-	-
25.	M	-	.5	-	1.5	1.5	1
26.	F	.5	-	.5	.5	3	4
27.	F	.5 med .5		-	.5	1.5	2
28.	F	.5	.5	-	-	1	1
29.	M	.5	.5	1.5	3	-	4
30.	M	-	-	-	2	1	-
31.	M	.5	.5	-	-	1.5	2

Asiatic. India. XXI.B. Central India.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXI.B.		L.	R.	L.	R.	L.	R.
1.	M	1	1	-	1,1	3	3
2.	M	1	1	-	-	1	3
3.	F	-	-	-	-	-	3
4.	M	-	-	1	-	1	1
5.	M	-	-	.5	.5	-	-
6.	M	1	.5	-	1.5	-	4
7.	M	1 median		-	-	2	2
8.	F	-	-	-	-	1	1
9.	F	-	-	-	-	2	3
10.	M	-	-	1	1	2	2
11.	F	-	-	-	-	-	-
12.	F	-	-	2	3	3	-

D. Southern Provinces.

1.	M	.5	1	-	.5	1.5	1.5
2.	M	-	-	-	-	1.5	1.5
3.	M	1	.5	-	-	3	-
4.	M	-	-	-	-	2	3
5.	M	-	-	-	-	1.5	3
6.	F	1	-	.5	-	-	1
7.	M	-	-	-	-	2.5	-
8.	M	.5 median		-	.5	1.5	3
9.	F	-	-	-	.5	3	3.5
10.	M	-	-	1	.5	1.5	3.5
11.	F	-	-	1	.5	1	1.5
12.	F	-	-	-	-	1.5	1.5
13.	M	1	-	-	.5	1	.5

Asiatic. India. XXI.D.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXI.D.		L.	R.	L.	R.	L.	R.
14.	M	-	-	1.5	-	1	3
15.	M	-	-	/	-	-	1.5
16.	M	-	-	/	/	/	/
17.	M	-	-	-	.5	3	4
18.	M	-	1	1	1	-	-
19.	M	1	-	-	1	/	/
20.	M	-	1	1	-	2	2
21.	M	.5	1	-	1.5	1.5	-
22.	M	.5	.5	1	.5	-	2
23.	M	-	.5	2.5	2	-	-
24.	M	/	/	-	.5	4	4
(N.W. and Punjaub.)							
E1.	M	.5	-	-	-	1.5	-
E2.	M	-	-	1	1.5	-	-
E3.	M	-	.5	-	-	-	-
E4.	M	1.5	-	1	-	1	1.5
E5.	M	.5	.5	-	-	1	1
(N.E. and Nepal.)							
F1.	M	.5	-	1	1.5	1	1.5
F2.	M	-	-	-	-	1	1.5
F3.	M	1	.5	-	-	-	2
F4.	M	.5 median		-	-	/	/
F5.	M	1	1	1,1	1,1	1.5	1.5
F6.	M	-	-	-	1	/	/
F7.	M	.5	.5	-	.5	1.5	1.5
F8.	M	-	-	-	.5	/	/
F9.	F	1 median		-	-	1.5	-

Asiatic. India. XXI.F.

No.	Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
XXI.F.							
10.	M	-	.5	1	1	2	1
11.	M	-	.5	-	-	1.5	2
12.	M	1	-	-	-	1	1
13.	M	.5 .5m	.5	.5	-	3	1.5
14.	M	-	.5	1	.5,.5	1.5	3
15.	F	-	-	1	.5,.5	1.5	1.5
16.	M	-	-	2	4	-	.5
17.	M	.5	-	.5	.5	1	1
18.	M	.5	.5	.5	1.5,1.5	1	-
19.	F	-	1	2	1	1	.5
20.	M	.5	-	-	3.5	1.5	.5
21.	M	1	1	.5,1	-	-	1.5
22.	M	-	.5	1	.5	2	3.5
23.	F	-	.5	/	/	1	-
24.	M	-	.5	-	1.5	-	-
25.	M	.5	.5	1	-	1.5	1.5
26.	M	-	.5	1,2	2	-	-
27.	F	-	.5	-	-	1	1.5
(Ceylon.)							
G1.	M	-	-	-	-	1.5	2
G2.	F	1	-	1.5	-	-	1.5
G3.	M	1	-	-	-	-	-
G4.	F	-	-	-	-	3	2
G5.	M	.5	.5	1	2,1	2	-
G6.	F	-	.5	.5	-	1.5	3.5
G7.	M	.5	1	-	.5	3	2
G8.	M	.5	.5	-	1.5	.5	1.5

Asiatic. Indian. XXI.G.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXI.G.		L.	R.	L.	R.	L.	R.
9.	M	-	-	-	-	2	3.5
10.	M	.5	-	-	-	2	1.5
11.	F	-	-	2	3.5	-	-
12.	M	-	1	1	-	1.5	3
13.	F	-	-	.5	.5	1.5	2
14.	F	.5	1	.5	/	-	1.5
15.	F	-	-	1	-	-	-
16.	F	-	.5	.5,.5	1	1.5	1
17.	M	.5	-	.5,1.5	.5	-	-
18.	M	-	-	-	1	1	1
(Veddah.)							
H1.	M	-	-	-	-	1	3.5
H2.	M	1	.5	-	-	1	2
H3.	M	.5	-	3	1	-	-
H4.	M	-	-	-	1	-	-
H5.	M	.5	-	-	-	1.5	2
H6.	M	-	-	-	-	3	1.5
H7.	F	-	-	-	-	-	1
H8.	M	-	-	-	-	.5	3
(Indeterminate.)							
J1.	F	.5	-	-	1	1.5	--
J2.	F	-	-	.5	-	1.5	1.5
J3.	M	-	1	-	-	1.5	2
J4.	F	-	-	-	-	2	3
J5.	M	-	1	-	3	4	-
J6.	M	-	-	1	1.5	-	2
J7.	F	-	-	-	-	-	-

Asiatic. Indian. XXI.J.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXI.J.		L.	R.	L.	R.	L.	R.
8.	F	1	1	.5	-	1	1.5
9.	F	.5	.5	.5	1	-	-
10.	F	-	-	-	-	-	-
11.	M	-	1	-	-	-	-
12.	M	-	.5	-	-	3	2
13.	F	.5	.5	1	.5	.5	2
14.	F	-	1	-	1	-	-
15.	M	1	-	-	-	.5	.5
16.	F	-	-	.5	-	3	1
17.	F	.5	.5	-	-	2	-
18.	M	-	-	-	-	1	3
19.	F	-	.5	.5	-	1.5	1
20.	M	1	-	-	-	1.5	1.5
21.	F	-	-	.5	.5	1	3
22.	F	-	1	1	1.5	-	.5
23.	M	-	-	-	1	-	.5
24.	F	-	-	-	.5	2	2
25.	M	-	-	-	-	2	2
27.	M	-	.5	.5, .5	.5, .5	-	3
28.	M	.5	1	-	.5	2	-
29.	M	.5	-	.5	1	-	1
30.	M	-	-	1	-	1	.5
31.	M	1	-	-	-	1	3.5
32.	M	-	-	-	-	1	.5
33.	M	1.5	-	.5	.5	2	2.5

Asiatic. Indian. XXI.J.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXI.J.		L.	R.	L.	R.	L.	R.
34.	M	-	-	-	-	2	1.5
35.	M	.5	-	-	-	1.5	3.5
36.	M	-	1	.5	.5	-	-
37.	M	.5	-	-	1	1.5	1
38.	M	-	-	-	-	1.5	2
39.	F	1	1	-	1.5	-	3
40.	F	-	1	1.5	1.5	2	-
41.	F	.5	-	.5	.5	3	4.5
42.	M	1	1	.5	2	2	3
43.	M	.5	.5	1.5	1.5	1.5	1.5
44.	M	.5	.5	-	1,1.5	2	3.5
45.	M	-	-	1	1	2	1.5
46.	M	1	.5	.5	-	-	-
47.	M	-	-	.5,1.5	1.5	2	3
48.	M	.5,.5 median		1	-	-	-
49.	M	-	.5	-	-	-	.5
50.	F	-	-	.5	-	3	1
51.	M	-	-	-	-	-	-
52.	M	1 median		1	1	3	2
53.	M	-	-	-	-	1	-
54.	F	-	-	1	-	1	3
55.	F	-	-	-	.5	-	1.5
56.	F	-	-	-	1	1.5	3
(Burmese.)							
K1.	M	.5	-	-	1	1.5	1.5
K2.	M	1	.5	1	3	1.5	-

Asiatic. India. XXI.K. Burmese.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXI.K.		L.	R.	L.	R.	L.	R.
3.	M	1	.5	-	3	2	1.5
4.	M	.5	1	3	1	-	-
5.	M	.5	1	-	-	2	1
6.	M	1.5 median		1	3	-	2
7.	M	-	1	-	-	1.5	1
8.	M	1	.5	-	-	1.5	2
9.	M	.5	-	.5	-	-	.5
10.	M	-	-	1	1	-	-
11.	M	.5	-	1.5	3	-	-
12.	M	1	.5	1	.5,1.5	1.5	2
13.	M	.5	1	-	1	-	.5
14.	M	.5	÷	1.5	-	-	-
15.	M	.5	1	1	-	.5	-
16.	M	.5	.5	3	1	-	1
17.	M	.5	1	1,.5	.5,.5	2	1
18.	M	.5,.5	.5	1	-	1.5	1
19.	M	1	-	1,1,1.5	-	-	4
20.	M	.5	1	.5	2.5	-	1.5
21.	M	1	1	1	--	-	-
22.	M	1 median		1	-	1.5	3
23.	M	1	1	1	2	-	-
24.	M	.5	.5	-	-	1.5	1.5
25.	M	.5	.5	1	1.5,1.5	-	-
26.	M	-	.5	1.5	1.5	1.5	3
27.	M	-	-	-	-	-	1

Asiatic. Indian. XXI.K. Burmese.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXI.K.		L.	R.	L.	R.	L.	R.
28.	M	.5 median		2	4.5	1	-
29.	M	-	.5	.5	1.5	-	.5
30.	M	.5	.5	-	-	3	3
31.	M	-	1	1.5	1.5,1	2	3.5
32.	M	1 median		-	-	1.5	1
33.	M	.5	1	1	.5,1.5	-	1.5
34.	M	-	-	2	-	1.5	1.5
35.	M	1	-	3	1.5	.5	1
36.	M	1	.5	1.5	1.5	-	-
37.	M	1 median		.5	1	-	-
38.	M	1	-	1	-	-	-
39.	M	-	-	1	-	2	-
40.	F	1	1	1	1	.5	1.5
41.	M	-	.5	1	1	3	2
42.	M	.5	-	-	1.5	1.5	-
43.	M	-	-	-	-	1	1
(Shan States.)							
L1.	M	1	1	-	3	1.5	-
L2.	F	.5	-	-	-	-	-
L3.	F	-	.5	1	1	1	1.5
L4.	F	-	-	1.5,1.5	-	1	2
L5.	F	1	-	.5	-	/	/

XXII. Malaysian. A. Siamese.

A1.	F	-	-	-	-	1.5	2
A2.	F	-	1	-	-	.5	-
A3.	F	.5	.5	1	-	1.5	-
A4.	F	-	-	1.5	1.5	1	1

Asiatic. Malaysian. XXII.A. Siamese.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXII.A.		L.	R.	L.	R.	L.	R.
5.	F	-	-	-	-	-	1
6.	F	-	-	1	1	1	1
7.	M	-	-	1.5	1	3.5	3.5
8.	M	-	-	1.5	1,1	1.5	1
9.	M	-	.5	-	-	-	3
10.	M	-	-	1	-	3.5	3
11.	M	-	.5	1	1	-	2
12.	M	.5	1	1	1.5	1	2.5
C. Malay.							
1.	F	-	1	.5	1	4	4
2.	M	-	1	1.5	/	/	/
3.	F	-	1	2	-	1.5	1.5
4.	M	1	1	-	-	1	1
5.	M	-	1	-	-	3	2.5
6.	M	-	.5	-	1.5	4	3
7.	M	.5	.5	-	-	1.5	2
7a.	F	-	-	/	/	/	/
8.	F	-	-	-	-	2	/
9.	M	-	-	/	1	/	/
10.	M	-	-	-	1	/	/
11.	M	-	-	-	1.5	/	/
12.	M	-	-	-	-	/	/
13.	F	-	1	1.5	-	-	-
14.	M	-	-	/	-	1.5	1.5
15.	M	-	1	1,1	2,1	1	-
16.	F	.5	.5	1.5	2	-	-

Asiatic. Malaysian. XXII.C. Malay.

No.	Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
XXII.C.							
17.	M	-	-	1	-	1.5	2
18.	M	-	1	-	-	1.5	1.5
19.	M	-	1	-	1.5	2	-
20.	F	.5	.5	-	-	-	-
21.	F	.5	-	.5	1	1.5	1
22.	M	-	-	1	.5	1	1
23.	M	.5	.5	1.5	-	-	1.5
24.	M	.5	1	1,1	1,1	/	-
25.	M	-	.5	2	1.5	2	-
26.	F	-	-	-	-	1.5	-
27.	M	.5	1	-	1	1	-
28.	F	.5	1	.5,.5	-	1.5	-
29.	M	1	.5	3.5	3	-	-
(Andaman.)							
D1.	M	-	-	1.5	2	1	3.5
D2.	M	-	-	-	1.5	-	-
D3.	M	-	-	.5	-	2	3.5
D4.	F	-	1	-	.5	-	-
D5.	M	-	.5	.5	-	1.5	3
D6.	F	-	-	-	-	1.5	1
D9.	F	-	1	-	-	-	1
E1.	M	-	1	-	1	/	/
E2.	F	-	-	-	1	1.5	2
(Borneo.)							
F1.	M	-	1	1	3.5	-	2
F2.	M	.5	-	-	1.5	1	1.5
F3.	M	-	-	-	1	-	-

Asiatic. Malaysian. XXII.F. Borneo.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXII.F		L.	R.	L.	R.	L.	R.
4.	M	.5	-	-	1	1.5	3
5.	M	-	-	2	-	1.5	1.5
6.	M	.5	.5	.5	1.5	3	3
7.	M	/	/	-	.5	2	2
8.	M	.5	1	1.5	1.5,4, 1.5	-	-
9.	M	-	-	1	-	2	2
10.	F	.5	-	2.5	-	1.5	-
11.	M	-	-	3.5	-	2	1.5
12.	M	1	-	1	1.5	-	1.5
13.	F	-	-	-	-	2	3
14.	M	-	-	.5	.5,1	4	3.5
15.	M	-	-	2	1.5	1	2
18.	M	.5	1	1	1	2	1.5
G1.	M	.5	.5	.5,.5	2.5	1.5	1
K1.	M	-	1,.5	-	-	1	-
XXIII. Polynesia.							
A1.	F	--	.5	1	-	-	-
XXIV. Chinese. A. Tibetans.							
1.	M	1	.5	/	-	-	1
2.	M	.5	1	1,.5	2.5	1.5	-
3.	M	-	.5	1.5	1	1.5	1.5
4.	M	1	.5	1,1	-	1	1
5.	M	1 median		/	/	/	/
6.	F	-	-	3	-	-	-
7.	F	1 median		.5	1	.5	.5

Asiatic. Chinese. XXIV.B.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXIV.B.		L.	R.	L.	R.	L.	R.
1.	M	-	-	1	-	-	4
2.	M	.5	.5	-	1	3	3
3.	M	1	-	-	-	1	-
4.	M	.5	-	-	-	-	3
5.	M	-	.5	-	-	1.5	-
6.	M	-	.5	-	-	-	2
7.	M	.5	-	1	2	2	-
8.	M	.5	.5	3.5	2,1	1	1.5
9.	F	1	1	1.5	-	-	1.5
10.	F	-	1	1	-	-	1.5
12.	M	-	-	-	1.5	1	1
13.	M	-	-	1	-	1	/
14.	M	.5	-	1.5	3.5	3	-
15.	M	.5	.5	-	-	-	1.5
16.	M	-	.5	2	1.5	-	-
17.	M	.5	1	-	1	2	1.5
XXV.A.Japan.							3
1.	M	1	1	1	1	-	3
2.	M	.5	.5	2	1,1.5	1	2
3.	F	.5	-	-	1	2	-
(Formosa.)							
B1.	M	.5	.5	3	2.5	1.5	-
B2.	M	-	1	1.5,1	1.5	-	-
B3.	M	-	-	-	2	2	3.5
B4.	M	-	-	1,1	1.5	-	1.5
XXIV.B.Chinese. See above.							
11.	M	1	1	1.5	-	-	1.5

African. XXVI.A. North.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXVI.A.		L.	R.	L.	R.	L.	R.
1.	M	-	-	-	1.5	1.5	1
2.	F	-	-	-	1	-	1.5
3.	M	-	.5	.5	-	1	-
4.	F	.5	.5	-	-	1.5	1.5
5.	F	/	/	-	1	1.5	1
6.	F	/	/	-	/	1.5	1
7.	M	1	-	1.5	.5	1.5	/
8.	M	.5	1	1	1	2	-
9.	M	.5 median		-	-	1.5	1
10.	M	-	-	1	-	-	2
11.	M	.5	1	-	-	-	1
12.	M	1	1	-	.5	/	/
13.	M	1	-	1	-	/	/
14.	F	1	1	.5	-	2	2
15.	M	.5 median		-	-	-	1.5
16.	F	-	-	1	1	-	.5
17.	M	-	-	-	-	/	/
18.	M	1	.5	1	-	-	-
19.	M	-	-	-	-	-	-
20.	F	.5	.5	.5	-	1.5	1.5
21.	M	-	1	1	1.5	-	-
22.	F	-	-	.5	.5	1	1.5
23.	F	.5	1	-	-	3	3.5
24.	M	-	-	3	.5	-	-
25.	M	-	-	1.5	-	3	4

African. XXVI.A. North.

No.	Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
XXVI.A.		L.	R.	L.	R.	L.	R.
27.	M	-	-	-	1	2	2
29.	F	-	-	-	-	1	1.5
30.	F	-	-	-	1.5	2	-
31.	M	.5	.5	.5	1	3	-
32.	F	-	-	-	.5	/	/
38.	M	1.5 median		/	/	/	/
39.	F	1	-	/	/	/	/
40.	M	-	-	-	/	/	/
42.	M	-	-	/	/	/	/
43.	M	-	-	/	/	/	/
44.	F	-	-	-	1.5	/	/
45.	M	.5	-	.5	-	1,1	.5
46.	F	-	.5,1	1	1.5	3	1.5
47.	M	-	-	1.5	3	2	3
48.	M	/	/	1	2	-	-
49.	M	-	-	1.5	1.5	-	-
50.	M	.5	.5	-	2	.5	1
51.	M	-	.5	-	/	/	/
52.	M	-	-	-	-	-	-
53.	F	.5	-	1.5	-	2	1.5
54.	F	-	-	1	-	1.5	-
55.	F	-	-	.5	1.5	2	2
56.	F	-	-	-	1	2	-
57.	M	-	1.5	2	-	-	-
58.	M	-	1	1	2	1.5	-

African. XXVI.A. North.

No.	Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
XXVI.A.		L.	R.	L.	R.	L.	R.
60.	F	-	-	-	1.5	1	1
61.	M	.5	.5	2	1.5,1.5	-	--
62.	M	-	-	-	-	4	-
63.	F	.5	.5	1.5	1.5	-	1
(Central.)							
B.1.	M	-	-	1	-	2	3.5
B.2.	M	-	-	.5,1	-	3	3.5
(East Africa.)							
C1.	F	-	-	3	2	-	1
C2.	F	-	-	.5	-	-	-
C3.	M	-	-	-	1.5	3	3.5
C4.	M	-	.5	-	-	-	-
C5.	F	-	-	1.5	1	-	-
C6.	F	-	-	-	1	1	1.5
C7.	F	-	-	-	-	-	-
C8.	M	-	.5	1	1	1	1.5
C9.	F	-	1	-	1	1	3.5
C10.	F	.5	.5	1	/	.5	-
C11.	F	.5	1	-	-	.5	2
D. West Africa.							
1.	F	-	-	1	1	1	1
2.	M	.5,.5	.5,.5	-	-	-	-
3.	F	-	-	-	-	-	-
4.	F	-	-	1	1.5	1.5	-
5.	M	-	1.5	1,.5	.5	3.5	4
6.	M	-	-	1	-	1.5	1.5
7.	F	1	-	-	-	-	2
8.	F	-	-	/	-	1	-

African. XXVI.D. West.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXVI.D.		L.	R.	L.	R.	L.	R.
9.	M	-	-	-	1.5	2	2
10.	F	1	1.5	.5	.5	2	2
11.	M	.5	-	-	-	.5	2.5
12.	F	-	-	-	-	1	-
13.	F	-	-	1	1	1	2
14.	M	-	1	-	-	-	1
15.	F	.5	-	-	-	4	3
15a.	M	1.5	-	1.5	1,1	3	1.5
16.	M	.5	.5	1.5	1.5	1.5	-
17.	M	1	1	1	1.5,1.5	/3	1
18.	M	.5	-	1	-	1	-
19.	M	1	-	-	-	.5	.5
21.	F	1	-	.5	.5	3	.5
22.	F	-	-	.5	2.5	.5	2
23.	M	-	.5	-	-	-	3
24.	M	-	-	.5	1.5	-	1.5
25.	M	.5	-	-	1.5	1	1
26.	M	-	-	-	1	1	3
27.	F	-	.5	2	-	2	2
28.	F	-	-	1.5,.5	1	3	-
29.	F	-	1	1.5,1	3	-	-
30.	M	-	-	-	-	-	-
31.	M	-	.5	1	.5	-	2
32.	M	.5	-	-	-	3	1
33.	F	-	-	1.5	1.5,.5	3	1
34.	M	-	1	-	-	3	-
35.	F	-	-	-	-	1	.5,1

African. XXVI.E. South.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXVI.E.		L.	R.	L.	R.	L.	R.
1.	F	-	-	-	-	-	1
2.	F	-	.5	.5	.5,.5	1	1.5
3.	M	1	1	.5	1	1	1.5
4.	F	-	-	1.5	-	1.5,1.5	-
5.	F	-	1	1.5	.5,.5	3	3.5
6.	M	-	1	1	1	/	/
7.	M	.5 median		1	-	2.5	-
8.	F	.5	.5	-	.5	-	-
9.	M	.5	.5	1	1	1.5	-
10.	M	-	-	-	1	1.5	1.5
11.	M	-	-	-	-	-	-
12.	F	.5	.5	-	-	.5	1.5
13.	F	-	-	1	1	/	/
14.	M	-	-	-	-	-	-
15.	F	-	-	1	1	-	1.5
16.	F	-	.5	.5	.5	1	1
17.	M	1	-	-	-	1.5	4
18.	F	-	-	1	-	-	1.5
19.	F	-	.5	1	1	-	.5
20.	F	-	.5	-	-	-	-
21.	F	-	.5	.5	.5	1	1.5
22.	M	-	.5	-	-	-	2
23.	F	-	.5	-	1.5,.5	1.5	-
24.	M	-	-	-	1	.5,.5	-
25.	F	1	1	=	=.5	-	2

African. XXVI.E. South.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXVI.E.		L.	R.	L.	R.	L.	R.
26.	F	.5	1	2	2.5	-	-
27.	M	.5	-	1,.5	1	3	-
27a.	M	-	1	.5	.5	-	-
28.	M	-	1	1	1	-	1.5
29.	M	-	1	.5	-	1.5	1.5
30.	F	.5	-	-	-	1.5	1.5
31.	F	-	.5	1	1	2	-
32.	M	.5 m .5		1.5	1.5	1.5	1.5
33.	M	.5 median		-	-	-	-
34.	M	-	-	1.5	.5	2	3
35.	F	-	.5	-	.5	1	1
36.	M	-	1	-	1.5	2.5	2
37.	F	1	1	-	-	-	2
38.	M	1	1	/	/	/	/
39.	M	-	-	/	/	/	/
40.	F	-	-	-	-	-	-
F. Negro.							
1.	F	1	.5	-	-	-	-
2.	M	1	1	-	1	1.5	1.5
3.	M	-	1	-	-	1.5	.5
4.	F	.5	.5	-	2	2	-
5.	M	-	-	1	-	-	1.5
6.	M	1 median		1.5	-	2	-
7.	M	-	-	-	-	-	-
8.	M	-	.5	.5	-	1	2,1
9.	F	-	-	1	1	1	-

African. XXVI.F. Negro.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXVI.F.		L.	R.	L.	R.	L.	R.
10.	F	.5	.5	1	.5	-	2
11.	F	-	-	1,.5	1.5,1	-	.5
12.	M	.5	-	-	-	1	-
13.	F	.5	1	1,.5	.5,2,1	2	3
14.	F	-	-	-	1	-	1
17.	M	.5	1	-	-	2	-
18.	M	-	-	-	-	1	-
19.	M	.5,.5 .5	1	.5	-	-	-
XXVII.	Madagascar.						
1.	M	-	-	1,.5	-	4	3
2.	F	-	-	1.5	1	3	3
3.	F	-	1	-	.5	-	3
4.	M	1	1	1	1.5	1.5	1.5
5.	M	1	.5	1.5	1.5	2	2
6.	M	1	1	-	1	3	1
XXVIII.	Oceania. A. New Guinea.						
1.	M	1	-	-	-	1.5	1.5
2.	M	1	.5	1.5	-	-	-
3.	M	-	-	-	-	-	2
4.	M	1	1	1.5,1.5/=		-	-
5.	F	1	.5	1	-	-	-
6.	M	1	.5	.5	-	2.5	2.5
7.	F	1,1	1,1	-	-	1.5	-
8.	F	-	1	-	.5,.5	1.5	.5
9.	F	.5	.5	-	-	-	-
10.	F	-	.5	-	1	-	-
11.	M	1	-	-	-	-	1.5

Oceania. XXVIII.A. New Guinea.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXVIII.A.		L.	R.	L.	R.	L.	R.
12.	M	-	-	1	1	/	/
13.	F	-	-	-	.5	/	/
14.	F	.5	1	.5	.5	/	/
15.	M	1	.5	.5	1	-	1.5
16.	M	-	1	-	1	-	1.5
17.	F	-	-	-	-	1	1
18.	M	.5	-	-	-	1.5	-
19.	F	1	1	.5	-	/	/
20.	F	-	-	-	1	1.5	1.5
21.	F	-	-	.5	.5	/	/
22.	M	-	-	-	.5	-	1.5
23.	M	1.5	-	.5	-	1.5	.5
24.	M	-	-	-	-	1.5	1.5
25.	M	-	1	1,.5	1,1	.5	1.5
27.	M	-	-	1.5	-	-	-
28.	F	-	-	/	/	1	1
29.	F	-	-	2	1,.5	2	1
30.	M	-	-	.5	-	-	-
31.	F	-	.5	1.5	1,1	-	-
32.	M	-	-	-	-	-	-
33.	F	.5	-	{1.5 1.5	2,.5	-	-
34.	M	-	-	.5	1.5	-	-
35.	M	-	-	-	1	-	1.5
36.	M	.5	.5	1,1	1.5,.5	-	-
37.	F.	-	-	.5	-	-	3.5

Oceania. XXVIII.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXVIII.B.		L.	R.	L.	R.	L.	R.
1.	M	-	.5	-	1.5	.5	3
2.	M	1	1	1	1	3	3
C. New Hebrides.							
1.	M	-	1	1	1,1	2	-
3.	M	1	1	1	-	2.5	.5
4.	M	.5	.5	-	-	1.5	2
5.	M	1	.5	1	1	2	2
6.	M	1	-	-	-	3	1.5
7.	M	.5	.5	1.5	.5	-	-
8.	M	1.5	-	-	-	1	-
9.	F	-	1.5	.5	-	1	-
11.	F	1,.5	.5	-	1.5	1.5	1.5
12.	M	.5	-	-	-	1.5	1
13.	M	-	-	1	-	-	-
14.	M	-	1.5	-	-	-	-
15.	F	1,.5	-	-	-	1.5	-
16.	F	-	.5	1	-	-	1
17.	M	1 median		3	1.5	3	4
18.	M	1.5	.5	-	1	2	2
19.	M	.5	-	1	2	1	-
20.	M	.5	1	1.5	1,1	1.5	-
21.	M	.5	1.5 med.	.5	.5	-	-
22.	F	1	.5	-	1.5	1.5	-
23.	F	.5	-	1	-	-	-
24.	F	-	-	-	-	1.5	1.5
25.	M	-	-	-	.5	1	1

Oceania. XXVIII.C. New Hebrides.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXVIII.C.		L.	R.	L.	R.	L.	R.
26.	M	-	-	1	-	-	1.5
27.	F	-	1	-	-	-	-
28.	M	1,.5	.5 med.	-	-	-	-
29.	F	-	-	2	-	3	2
30.	M	-	.5	1	.5	-	-
31.	F	-	1	1	-	2	-
32.	F	-	1.5	-	-	1.5	1.5
33.	M	-	1.5	-	.5	-	-
(Solomon Islands.)							
D1.	M	-	1	-	1	-	-
D3.	F	-	1	1	-	3	2
D4.	M	-	-	2	-	1	1.5
D5.	F	.5	.5	1.5	1	.5	.5
D6.	M	-	-	-	.5,1	3	4
(Admiralty Islands.)							
E1.	M	.5	1	1	-	3	2
E2.	M	.5	-	-	-	-	-
E3.	M	-	.5	1	1.5,.5	-	-
E4.	M	/	/	.5	-	-	-
E5.	M	1	-	-	-	2	1
E6.	M	-	-	2	2	1	1.5
E7.	F	-	.5	/	.5	1.5	1.5
E8.	M	1	-	1,.5	-	-	-
E9.	F	.5	.5	1	1	-	-
E10.	F	1	1	-	-	1.5	1.5
E11.	F	-	1	-	-	1.5	-
E13.	M	.5	.5	/	1.5	-	-
E14.	M	.5	1	-	2	.5	1

Oceania. XXVIII.F. Sandwich Islands and Hawaii.

No.	Sex.						
XXVIII.F.		L.	R.	L.	R.	L.	R.
1.	M	-	-	.5	1.5	.5	2
2.	F	1 median		2,1	.5	-	-
3.	M	1 median		-	-	1.5	2
4.	M	.5	-	.5	1	2	2
5.	F	1	1	-	-	2	3.5
6.	M	-	-	-	-	-	-
7.	M	-	-	-	/	/	/
8.	M	1	-	-	.5	1	1
9.	M	1	-	1.5	1	-	-
10.	F	-	-	2	1.5	2	1.5
11.	M	.5	-	-	2	2	2
12.	M	- 1 median		1	-	-	3
13.	F	-	-	.5	.5	-	-
14.	M	1 median		-	-	-	.5
15.	M	.5	-	-	-	-	-
16.	F	-	-	-	1	1.5	1.5
17.	M	.5	.5	-	-	-	3
18.	M	-	-	-	-	-	1
19.	M	.5	.5 med	-	-	2	2
20.	M	-	-	-	-	/	2
21.	M	-	-	-	-	2	2
22.	M	-	-	-	2	-	2
23.	M	-	-	1.5	-	1.5	2
24.	M	-	-	1	-	1.5	2
25.	M	-	-	1.5	1	-	2

Oceania. XXVIII.F. Sandwich Islands.

No.	Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
XXVIII.F.							
26.	M	-	-	1, .5	1	2	.5
27.	M	-	1	.5	-	2.5	3
28.	M	1	-	1	.5	2	/
29.	F	-	-	1	-	/	/
30.	F	-	-	-	-	2	2
31.	M	-	-	1.5	-	/	3
32.	F	-	-	1	-	1.5	2
33.	F	1	-	.5	1	/	/
34.	F	-	-	-	-	-	1.5
35.	F	-	-	1	1.5	-	.5
36.	F	-	-	-	-	2	-
37.	F	-	.5	1.5	1	-	-
38.	F	-	-	1.5	.5	-	3.5
39.	M	-	-	-	-	2	3
40.	M	-	-	.5	1	-	-
41.	M	-	-	-	-	1.5	1.5
42.	M	-	-	1.5	1.5	-	-
43.	F	-	-	-	.5	.5	-
44.	F	-	-	-	-	2	1
45.	M	-	-	-	-	-	1.5
46.	M	-	-	.5	.5	-	-
47.	M	-	1	1.5	2	-	1
48.	F	-	.5	-	1	-	1.5

G. Chatham Islands.

1.	M	-	-	-	-	-	-
2.	M	-	-	-	-	-	-

Oceania. XXVIII.G. Chatham Islands.

No.	Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
XXVIII.G.		L.	R.	L.	R.	L.	R.
3.	F	1	1	-	-	1	3
4.	F	.5	.5	-	-	2	1.5
5.	M	-	-	2	1.5	-	1
6.	M	-	-	-	-	-	-
7.	F	1	-	1.5	2	1.5	1
8.	M	1	1	-	-	3	2
9.	M	.5, 1.	.5	-	-	-	1
10.	M	.5,1.5	.5	-	-	1	2
11.	M	-	1	-	-	-	-
12.	F	-	-	-	-	-	2
13.	M	-	1	-	-	1.5	-
14.	M	-	-	1,1.5	-	1.5	1.5
15.	M	-	-	-	-	1.5	1.5
16.	F	-	-	-	-	1	2
17.	M	-	-	1	1	1	1
18.	M	-	.5	1	1	1	1.5
19.	F	.5	1 median	1	1	1.5	1.5
20.	F	-	.5	-	-	3	2
21.	F	.5	.5	1	1	1.5	3
22.	M	-	.5	-	-	1.5	-
23.	M	-	-	-	-	1	1
H. New Caledonia.							
1.	M	-	.5	-	-	-	-
2.	F	-	-	1	1.5	-	-
3.	F	-	1	.5	1.5	-	-
4.	M	-	-	-	-	-	3

Oceania. XXVIII.H. New Caledonia.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXVIII.H.		L.	R.	L.	R.	L.	R.
5.	M	-	1	1.5	1	.5	1
6.	F	.5	.5, .5	-	-	-	1
7.	F	-	1	1	1	1	-
8.	F	1	-	1	1	-	.5
9.	M	.5	-	-	-	3	-
10.	M	.5, .5	.5	-	-	1.5	-
11.	M	1	-	-	1.5	3	-
12.	M	-	-	-	-	.5	-
13.	M	-	.5	-	1.5, 1	2	1.5
14.	M	-	-	.5	-	.5	-
15.	M	1 median		-	-	1	-
16.	M	-	.5	1	1	2	-
17.	F	-	-	.5	-	3.5	4
18.	M	-	-	1	-	3	3.5
19.	F	-	-	.5	1.5	1	1.5
I. Fiji Islands.							
1.	M	-	.5	-	-	-	1.5
2.	M	1	.5	.5	1	1	2
3.	M	-	.5	1	1	-	-
4.	F	-	-	.5	.5	1.5	3
5.	M	-	1	1, 1	1	3.5	3
J1.	M	-	.5	-	-	-	1.5
J2.	M	1	-	1	.5	-	2
K1.	F	.5	1	-	1	.5	-
N1.	F	1	1	/	-	3	4.5
N2.	M	-	-	.5	.5	.5	-

Australia. XXIX.A. Queensland.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXIX.A.		L.	R.	L.	R.	L.	R.
1.	M	-	1	-	.5	1.5	-
2.	M	1	-	.5	-	-	-
3.	F	.5 med 1rt		-	-	1.5	1.5
4.	M	1 median		-	1	-	-
5.	F	.5	-	.5	-	.5,1	.5,1
6.	M	-	-	1.5	1	-	-
7.	M	-	-	/	/	/	/
8.	M	1 median		1	1.5	-	-
9.	M	-	-	-	1	/	-
10.	M	-	-	1,1	1,1	-	-
11.	M	1 med .5 rt		-	.5	2	2
13.	M	1	1	1	1	-	-

B. New South Wales.

2.	M	-	-	1	1	2.5	1
3.	F	-	1	-	-	2	-
4.	M	1	-	-	-	-	-
5.	M	1 median		-	-	-	-
6.	M	-	.5	-	-	1.5	1.5
7.	M	1 median		.5	1,.5	-	-
8.	F	1	.5	.5	-	-	-
9.	M	-	-	1,.5	-	-	-
10.	M	-	-	1.5	1.5	-	-
11.	F	1	-	-	-	-	.5
12.	M	.5	1	-	-	1.5	1.5
13.	M	.5	-	1.5	.5	.5	-

Australia. XXIX.B. New South Wales.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXIX.B.		L.	R.	L.	R.	L.	R.
14.	M	-	1.5	-	-	1,1	.5
15.	F	-	.5	-	-	-	-
16.	M	-	-	-	-	-	-
17.	F	1	-	-	-	-	-
18.	M	1 med	1 rt	1	2.5	-	-
19.	M	.5 med	.5 rt	-	-	-	-
20.	M	-	-	-	-	3.5	-
21.	M	-	-	-	1	1.5	1.5
23.	F	1,1	1.5	-	1.5	2.5	-
24.	M	-	-	1	-	-	-
25.	M	1	-	-	-	-	1
26.	F	-	.5	-	-	/	/
27.	M	-	-	.5	-	-	1.5
28.	M	-	-	.5	-	.5	-
C.	Victoria.						
1.	M	-	-	1	-	-	1
2.	M	1.5	.5	.5	-	-	-
3.	M	-	.5	-	-	1.5	-
4.	M	1	.5	-	-	-	-
5.	M	-	-	-	-	1	.5
6.	M	.5 median		-	-	2	2
7.	F	-	-	/	.5	1.5	1.5
8.	F	.5	1	1	-	2	.5
9.	M	-	-	2	1,2	.5	-
10.	M	-	1.5	-	1	1	1
11.	F	-	-	1.5	2	1	1

Australia. XXIX.C. Victoria.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXIX.C.		L.	R.	L.	R.	L.	R.
12.	M	-	.5	1.5,.5	1	-	2
13.	M	1	1	1.5	.5	-	-
14.	F	-	-	1	.5	-	1.5
15.	F	1	-	-	.5	2	1.5
16.	M	-	-	-	-	/	/
17.	M	-	1.5	-	-	/	/
18.	M	1	-	-	1.5	1.5	1.5
19.	F	-	.5	-	-	2	3
20.	M	1	1,1	1	.5	1.5	4
21.	M	-	-	-	-	-	-
22.	M	-	.5	1	.5	-	1
23.	M	-	1	-	1	/	/

D. Northern Territory.

1.	M	-	-	3	.5	-	-
2.	F	-	-	.5	-	1	2
3.	F	-	1	-	-	-	-
4.	M	-	.5	.5	-	.5	2
5.	M	-	1	-	-	1.5	-
6.	F	-	-	1	-	-	-
7.	M	1.5	-	-	.5	2	1
8.	F	-	.5	-	-	1	2
9.	M	.5	1	1	.5,1	-	1
10.	F	-	1	.5	-	1.5	2
11.	M	1	1	-	-	-	-
12.	M	.5	1	-	-	1.5	-
13.	M	-	1	-	-	3	-

Australia. XXIX.D. Northern Territory.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXIX.D.		L.	R.	L.	R.	L.	R.
14.	F	-	1	-	-	.5	1.5
15.	F	1.5 median		-	-	1, .5	2.5
16.	M	-	.5	.5	.5	1.5	2.5
17.	M	-	1	-	1	1.5	2
18.	M	-	-	1	-	-	1.5
19.	M	-	-	-	-	-	-
20.	M	1 median		-	-	2	1
21.	F	-	-	.5, .5	1	1	/
22.	F	.5	-	1, .5	1.5	1.5	1
23.	F	-	.5	1	.5	-	1
24.	M	1	-	-	-	-	-
25.	F	.5, 1	-	1	-	-	1
26.	F	-	.5	-	.5	2	1
27.	M	-	1	-	-	1	1
28.	M	-	-	1	1	-	-
30.	M	-	-	-	1	-	2
31.	M	4x7 m.m.	-	-	-	/	/
32.	M	-	-	1.5	-	-	-
33.	M	-	-	-	-	-	.5
34.	F	1 1med	.5rt	-	-	-	1
35.	F	1, .5	1.5, .5	-	-	1.5	1.5
37.	F	.5	-	-	-	.5	-
38.	M	-	-	-	-	1	-
39.	M	1	1	-	-	-	-
40.	M	-	-	-	-	1.5	1.5

Australia. XXIX.D. Northern Territory.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXIX.D.		L.	R.	L.	R.	L.	R.
41.	F	-	-	-	.5	-	3
42.	M	-	1	-	-	/	/
43.	M	-	-	-	-	1.5	.5
44.	M	1 median		1.5	-	1	-
45.	M	-	-	-	-	-	-
46.	M	-	-	-	-	-	-
47.	M	-	-	-	-	2	3.5
48.	M	1.5	.5	1	.5	-	-
49.	M	1.5 median		-	1	-	-
50.	F	1	-	-	-	1	1
51.	M	1	-	-	1, .5	1	1.5
52.	M	1	.5	1	1	-	-
53.	M	1	1	.5	1	2	1.5
54.	M	.5	1	.5	.5	.5	1.5
55.	M	-	1	-	-	-	-
56.	F	.5	-	.5	.5	1.5	2
57.	F	-	-	-	1	-	.5
58.	F	-	-	-	.5	-	1
59.	M	-	-	.5	-	1.5	1.5
60.	M	-	-	.5	1	.5	1.5
61.	M	1	-	-	-	1.5	.5
62.	F	.5 1med	-	.5	-	-	-
63.	M	-	-	-	-	-	-
64.	M	.5	1	-	1	1.5	2
65.	F	.5	.5	-	-	-	1.5

Australia. XXIX.D. Northern Territory.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXIX.D.		L.	R.	L.	R.	L.	R.
66.	M	-	1	-	1	-	-
67.	F	1	-	1	-	2	3
68.	M	-	1	.5	.5,.5	1.5	2
69.	M	.5	2	-	.5	-	1
70.	M	-	-	.5,.5	-	1.5	3
71.	F	.5	1	1	.5	-	-
72.	M	-	-	-	-	-	-
73.	M	-	-	-	-	-	-
74.	F	-	-	-	.5	-	1
75.	M	-	-	-	-	-	-
76.	F	-	-	-	-	-	2
77.	F	1 median		-	-	1.5	2
78.	M	1	1	.5	1.5	1.5	-
79.	M	.5	.5	-	-	3	1.5

E. South Australia.

No.	Sex.	Parietal L.	Parietal R.	Mastoid L.	Mastoid R.	Occipital L.	Occipital R.
1.	M	.5	.5,.5	1	1.5,1.5	-	-
2.	M	-	1	-	-	-	-
3.	F	/	.5	/	1.5	/	-
4.	F	-	.5	.5	-	-	2
5.	M	-	-	1	1,.5	-	-
6.	M	1.5 median		1.5	1.5	1.5	-
7.	M	-	.5	.5	2	-	.5
8.	F	.5	-	1	1.5,1	1.5	-
9.	M	.5	-	-	-	-	1
10.	F	-	.5	.5	1.5	-	3
11.	F	-	.5	-	/	/	/

Australia. XXIX.E. South Australia.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXIX.E.		L.	R.	L.	R.	L.	R.
12.	M	-	1.5	1,1	/	/	/
13.	F	-	.5	-	-	.5	-
14.	M	1	-	-	1	-	-
15.	M	.5	-	-	-	-	1.5
15a.	M	-	.5	2	.5	1	2
16.	F	1	-	-	/	-	/
17.	F	.5	1	-	-	-	.5
18.	F	-	-	-	-	-	.5
19.	F	-	-	1	-	/	/
20.	M	-	1	1	1	-	-
21.	F	-	-	-	-	-	-
22.	F	-	-	-	-	1.5	3
23.	M	-	-	-	1	1	-
24.	F	1	-	/	-	/	/
25.	F	-	-	/	/	/	/
26.	F	-	-	-	-	-	-
27.	M	-	.5	-	-	-	-
28.	M	-	1.5	.5,1	.5	-	-
29.	M	-	-	1.5	1	-	-
30.	M	-	-	-	-	-	-
32.	F	1.5	-	-	/	-	1.5
33.	M	-	-	-	.5	1	1.5
34.	F	-	.5,.5	.5	1,.5	1	-
35.	F	-	-	.5	1	-	-
36.	M	-	-	1	-	1.5	1.5

Australia. XXIX.E. South Australia.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXIX.E.		L.	R.	L.	R.	L.	R.
37.	M	1	-	-	-	-	-
39.	M	-	.5	-	-	-	2
40.	M	1	1	-	-	.5	-
41.	M	-	-	-	-	1	-
42.	M	-	1.5	1	/	/	/
43.	M	1 median		.5,1	.5	1.5	-
44.	M	-	-	-	1	-	1
45.	M	-	-	-	-	-	-
46.	M	-	-	-	-	1.5	1.5
47.	F	-	-	/	/	/	/
49.	F	-	-	-	-	-	-
50.	F	-	.5,.5	1	.5	-	-
51.	F	1	1	-	-	-	-
52.	F	-	-	-	-	2	1.5
53.	F	-	-	-	/	/	/
54.	F	-	-	1	-	-	-
55.	M	1.5	-	2.5	-	.5	.5
56.	M	1	-	1.5,1	1	-	-
57.	M	1	1	1	-	2	2
58.	F	1	1	1	1	-	-
59.	F	-	1.5	1	1	-	1
60.	M	1	-	-	-	-	-
61.	F	-	1	1	1	/	/
62.	M	-	-	.5	.5	1	-
63.	F	1	1	/	/	/	/

Australia. XXIX.E. South Australia.

No.	Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
XXIX.E.							
64.	M	-	-	/	/	/	/
65.	M	2	-	-	-	-	-
66.	F	-	-	/	.5	1	-
67.	M	-	-	/	.5	/	/
68.	M	-	1	1	-	1	1
69.	M	1	-	1.5,1	/	/	/
70.	M	3 median		/	/	/	/
71.	M	1.5	-	-	-	4	1.5
72.	F	-	1.5	.5	-	/	/
73.	M	1.5 median		-	-	-	1
74.	M	.5	.5 med	2,1.5	1	1.5	1.5
75.	F	-	-	1	1	-	-
76.	M	1,.5	.5,.5	-	-	1.5	1
77.	M	1	1	-	1	-	-
78.	M	-	-	-	-	-	-
79.	M	1	.5	-	-	-	-
80.	F	-	-	-	/	-	1
81.	M	-	-	/	-	/	2
82.	F	1	-	/	1.5	/	/
83.	M	1 median		-	/	-	-
84.	M	1	-	1	.5	-	-
85.	M	-	1	-	-	-	.5
86.	M	-	-	2	.5	1.5	2
87.	F	-	1.5	-	-	-	-
88.	F	.5	-	-	-	1.5	1.5

Australia. XXIX.E. South Australia.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXIX.E.		L.	R.	L.	R.	L.	R.
89.	F	1 median		-	1	-	.5
90.	M	-	-	1.5	-	1.5	-
91.	M	1	1	-	/	/	/
92.	F	1	.5	1	-	-	1
93.	F	.5 median		1	/	-	-
94.	M	-	-	1.5	-	/	/
95.	F	1	-	-	-	1.5	2
96.	F	-	-	.5	.5	1	-
97.	M	1	-	/	/	/	/
98.	M	-	1.5	1	-	/	/
99.	M	1 median		1	1,.5	-	-
100.	M	-	-	/	/	/	/
101.	F	-	-	1	.5	1	-
102.	M	1 median		-	-	1	1
103.	F	-	-	-	-	-	-
104.	F	2.5	-	/	/	/	/
105.	F	1.5 median		/	/	/	/
106.	F	1	-	/	/	/	/
(West Australia.)							
F1.	M	.5,.5	-	1	1.5	1	-
F2.	M	-	-	-	-	-	-
F3.	F	-	-	1	-	1.5	1
F4.	F	1.5 median		-	1,.5	2	.5
F5.	M	-	.5	-	-	-	-
F6.	M	-	1.5	.5	-	-	-
F7.	M	1	-	-	-	1	-
F8.	F	1	.5	1	-	-	-

Australia. XXIX.G. Indeterminate.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXIX.G.		L.	R.	L.	R.	L.	R.
1.	F	1 median		-	-	.5	-
2.	M	-	-	-	-	-	-
3.	M	-	-	-	-	1.5	1.5
4.	M	/	-	/	-	/	-
5.	M	1.5	-	.5	-	.5	1
6.	M	.5	-	1	1.5	3	3.5
7.	M	.5	-	-	.5	1.5	1.5
8.	F	-	1	-	-	-	-
9.	M	-	.5, .5	.5, 1	1	3	-
10.	M	-	-	-	-	.5	1
11.	F	.5	-	1	1	.5	-
12.	M	.5	-	-	-	-	-
13.	F	-	-	-	-	1	-
14.	F	1	-	.5	1	1.5	-
15.	M	-	.5, 1	1.5	-	/	/
16.	F	.5	.5	1	1.5	1	-
		and .5 median					
17.	M	1	.5, 1	.5	-	-	2
18.	M	.5	.5	-	-	-	.5
19.	F	-	-	1	1, 1	1.5	-
20.	M	-	-	1.5	.5	-	1
21.	M	1	1	.5	-	-	-
22.	M	-	1	1	-	-	-
23.	M	.5	-	-	-	-	1
24.	M	.5	-	1	-	1	2
25.	M	.5	.5, .5	-	-	1.5	-

Australia. XXIX.G. Indeterminate.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXIX.G.		L.	R.	L.	R.	L.	R.
26.	F	-	-	-	/	/	/
27.	F	-	-	-	-	-	-
28.	F	.5	1	2	-	/	/
29.	M	-	-	/	-	/	/
30.	M	1	-	-	-	-	-
31.	M	-	.5	/	/	/	/
33.	M	-	-	1	1	-	1.5
34.	F	-	-	-	/	-	-
35.	M	1.5	1	-	-	-	-
36.	M	-	-	.5	.5	-	1
38.	M	-	-	-	.5	-	-
39.	M	.5	-	1.5	-	-	-
Tasmanian. XXX.							
2.	M	-	-	-	-	.5	1
3.	F	.5	.5	-	-	1.5	1.5
4.	M	-	1.5	-	1	-	-
5.	M	-	.5	-	.5	-	1
6.	M	-	-	-	1.5	-	-
7.	M	-	-	-	-	1.5	1.5
8.	F	-	-	-	/	/	/
10.	F	.5	.5	1,.5	1.5	-	.5
New Zealand. XXI.A.							
1.	M	.5	-	-	-	-	-
2.	M	1	-	1	-	.5	1.5
3.	M	-	.5	.5	-	-	1.5
4.	F	.5	-	-	-	.5	2
5.	F	-	-	1.5	-	-	-

New Zealand. XXXI.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXXI.		L.	R.	L.	R.	L.	R.
6.	F	-	1	1	1,1	-	-
7.	F	-	-	1	-	/	/
9.	M	-	-	2	1.5,2	/	/
10.	M	-	1	1	-	1.5	2
11.	M	1.5 med		-	-	-	-
12.	F	-	1	-	-	-	.5
13.	M	-	-	.5	-	-	1
14.	M	-	1	-	2	1	3.5
15.	M	-	1	.5	-	-	1.5
16.	F	-	-	-	1,1	-	-
17.	F	-	-	-	.5	1.5	2
18.	F	-	-	1	1	-	2
19.	M	.5	-	1.5	1.5	2	2
20.	F	-	-	-	.5	-	-
21.	F	1 median		-	.5	1.5	2
22.	F	-	-	1.5	1.5	1.5	-
23.	M	1	.5	-	-	1.5	1
24.	F	1	-	.5	1	1.5	1
25.	M	1	1	.5	.5	-	1.5
26.	M	1	1	-	-	-	1
28.	M	1	-	1.5	/	/	/
29.	F	-	-	.5	.5	2	1.5
30.	F	-	.5	1	.5	1.5	3.5
31.	F	-	-	-	1.5	-	-
32.	F	1	-	-	-	-	-

New Zealand. XXXI.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXXI.		L.	R.	L.	R.	L.	R.
33.	M	-	-	-	-	-	1
34.	F	1	-	-	1.5	-	1
35.	M	-	.5	-	-	1.5	1.5
36.	F	.5	-	-	-	-	-
37.	F	-	1	1	.5	2	1
38.	M	1	1	-	-	-	1
39.	M	-	-	-	-	1.5	1.5
40.	M	.5 median		.5,.5	.5,1.5	1.5	-
41.	F	-	-	/	1	-	1.5
42.	F	1	1	-	-	-	-
43.	F	1 median		/	-	/	/
44.	F	1.5 med		/	/	1	.5
45.	M	-	-	-	-	/	/
46.	M	-	.5	-	-	-	-
53.	M	-	.5	-	-	/	/
54.	M	.5	1	-	-	-	1
56.	M	-	-	-	-	1	1
57.	M	.5 median		1.5	1	2.5	2.5
58.	M	-	-	-	-	1	2
59.	M	1	-	-	-	-	-
60.	M	-	1	1	.5	.5	-
61.	F	1	-	-	-	1	-
62.	F	1	-	1	-	/	/
63.	M	-	-	.5	-	-	2.5
64.	M	-	-	-	.5	1	1

North America. XXXII.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXXII.A.		L.	R.	L.	R.	L.	R.
1.	M	-	-	-	-	-	.5
2.	F	.5	-	-	-	2	2
3.	M	-	-	-	-	2	2
4.	F	.5	.5	1	-	1.5	1.5
5.	M	1	1,.5	-	1.5	1.5	1.5
6.	F	-	.5	1.5	1.5	.5	1
7.	M	.5	.5	1,.5	.5	1.5	1
		and .5 median					
B.							
1.	M	-	-	1	1,1.5	-	2
2.	M	.5	-	-	1	1	1
3.	F	1	.5	.5	2	2	2
4.	M	.5	.5	2	.5,1.5	.5	1.5
5.	F	1	.5 med	-	1	.5	1.5
6.	F	-	.5	1,1	-	/	/
7.	M	.5	1	/	-	1.5	2
8.	M	1	-	.5	-	.5	1
9.	F	-	-	-	1.5	-	1.5
10.	F	1	1	.5	1	1.5	1.5
11.	M	1	-	-	.5	1.5	2
12.	M	-	1	.5	.5	4	2,3.5
13.	M	-	.5	-	-	-	-
14.	F	-	.5	.5,1	1	1.5	2
15.	M	-	-	.5	1	1.5	-
16.	M	1	1	.5	2	2	3
17.	F	-	.5	3	-	3	-
18.	F	-	-	.5	-	.5	-

North America. XXXII.B.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXXII.B.		L.	R.	L.	R.	L.	R.
19.	M	1.5 median		1	1	3.5	3.5
20.	M	-	1	-	.5,1	3	3
21.	F	-	-	-	-	1.5	2
22.	F	1	1	.5	-	2.5	2.5
23.	M	1	1	-	1.5	-	.5
24.	M	-	-	.5	1,.5	2	3
25.	F	-	.5	.5,1	1	1.5	2
27.	F	1	1	1	-	1.5	1.5
28.	M	-	.5	1	2.5	2	1
29.	F	1	1	1	2.5	2	3
31.	M	.5	1	-	.5,.5	3	1.5
32.	M	-	-	1.5	1	2.5	2

South American. XXXIII.A. Peru.

1.	M	.5	-	-	1	1	2
2.	M	.5	-	1.5	1.5	1.5	2
3.	M	1 med	.5	1	-	.5	2
4.	F	-	-	.5	1	-	2
5.	M	.5	-	1,1	-	1.5	2
6.	F	-	-	1,1.5	3.5	-	1
7.	F	-	-	-	-	-	1
8.	F	.5	-	-	1,1.5	-	-
9.	M	.5	-	.5	.5	1.5	2
10.	M	-	-	1	/	1.5	/
11.	F	-	1	.5	-	2.5	2
12.	F	1	1	.5,1	-	1.5	-
13.	M	-	1	1	1.5	/	/

South America. XXXIII.A. Peru.

No.	Sex.	Parietal.		Mastoid.		Occipital.	
XXXIII.A.		L.	R.	L.	R.	L.	R.
14.	M	-	-	2	1	-	-
15.	F	-	-	.5	1	1	1.5
16.	F	-	-	-	.5	1.5	1
17.	M	-	.5	1	2	2	1
18.	M	-	-	/	1,1.5	/	//
19.	F	-	-	-	1.5	1	1.5
20.	F	-	-	-	-	-	2
21.	F	1	-	.5	.5	1	-
22.	M	-	-	2	-	1	1
24.	M	-	-	2	-	2	.5
26.	M	1.5	-	-	-	.5	.5
27.	M	.5	.5	1.5	2	1	1.5
28.	F	.5	.5	-	1	1.5	2
29.	F	.5	-	1	1	2	2.5
30.	F	-	.5	2	1,1	3	2
31.	F	.5	.5	-	-	1.5	2
32.	M	1.5	-	-	-	.5	1.5
33.	M	-	-	-	3	1.5	2
B. Chilian.							
1.	M	1	-	1	1	1	.5
2.	F	.5 median		-	1.5	1	-
3.	F	1 median		.5,1	1	-	2
4.	M	1	-	-	-	1	.5
5.	F	.5	-	1	1	2	-
6.	M	.5	-	2	1,1.5	-	-
7.	M	-	-	.5	1	2	/

South America. XXXIII.B. Chili.

No.	Sex.	Parietal. L.	Parietal. R.	Mastoid. L.	Mastoid. R.	Occipital. L.	Occipital. R.
XXXIII.B.							
8.	M	-	1	-	.5	2	2
9,	F	-	1	.5	4	-	-
10.	M	.5	.5	1	1	2	2
11.	M	-	-	1	1.5	1.5	1.5
C. Patagonia.							
1.	M	1	1	.5	-	2	2
2.	F	1	.5	1	.5,1.5	1.5	2
3.	F	1	.5	1	1.5	2	2
4.	M	-	-	2	1.5,1	2	2
5.	M	-	1	1	1	1.5	2
D.1.	F	-	-	1,1	.5,1	1	1.5
E.1.	F	-	.5,1	-	-	-	2
F.1.	M	1	1	-	-	/	/
F.2.	F	-	-	-	-	1.5	1
F.3.	M	-	-	2	3.5	2	1.5
F.4.	F	-	.5	-	1	1	2
F.5.	M	.5	.5	2	1.5	1	2
F.6.	M	-	-	-	1.5	3	2
F.7.	M	-	-	2	.5,1	2.5	2
West Indian. XXXIV.							
A.1.	M	-	-	2	1	-	1
A.2.	M	-	-	/	/	/	/
A.3.	M	.5	-	-	-	-	-
A.4.	M	1	-	1.5	.5	3	3
A.5.	M	-	-	2	-	/	/
B.1.	M	-	.5	.5,3.5	1,2	2	-
B.2.	M	1	.5	1.5	1,3	1.5	2
B.3.	M	-	-	-	-	1	2